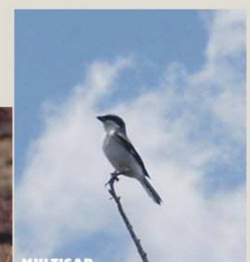
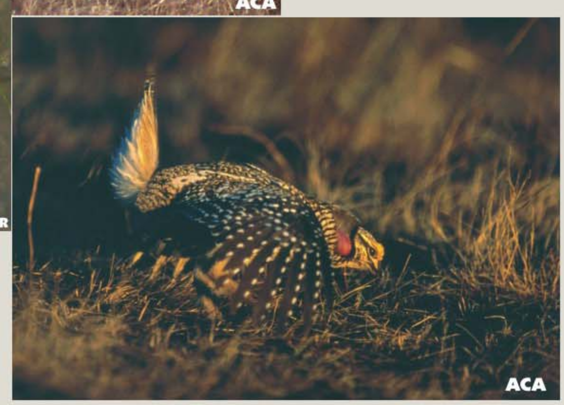
Beneficial Management Practices for the Milk River Basin, Alberta

A component of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR)





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Rangeland Conservation Service Ltd.
Environmental Services

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Alberta Conservation Association

Government of Canada
Habitat Stewardship Program

BENEFICIAL MANAGEMENT PRACTICES FOR THE MILK RIVER BASIN, ALBERTA

A component of the
Multi-Species Conservation Strategy for Species At Risk
in the Milk River Basin (MULTISAR)

Prepared for:

Alberta Sustainable Resource Development, Fish and Wildlife Division and
Alberta Conservation Association

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Rangeland Conservation Service Ltd.
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ABSTRACT

This report has been prepared as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR). This initiative was spearheaded by Alberta Sustainable Resource Development (SRD), Fish and Wildlife Division and the Alberta Conservation Association. The aim of the MULTISAR project is to implement a process to achieve multi-species conservation through appropriate management on critical parts of the landscape. The objectives of this project were summarized in the Year 1 Progress Report for the MULTISAR project (Alberta Species at Risk Report No. 72 - http://www3.gov.ab.ca/srd/fw/riskspecies/). At its core, the MULTISAR project emphasizes cooperative initiatives, partnerships and voluntary stewardship activities to achieve conservation of species at risk.

The Milk River Basin is located in southern Alberta, Canada and occupies an area of approximately 6,776 km^2. The basin extends north from the United States border along the Saskatchewan border to Cypress Hills Provincial Park and west to Whiskey Gap, Alberta (located east of Cardston). The unique landscapes, topography and remaining native prairie within the Milk River Basin and along the North Milk and Milk Rivers and their tributaries provide habitat to a diversity of wildlife. Numerous plants and animals within the Milk River Basin are at the northern limit of their North American range and are either unique to the basin or are rare anywhere else in Alberta or Canada. As many as 7 “At Risk”, 10 “May Be At Risk” and 27 “Sensitive” bird, mammal, fish, amphibian or reptile species are found within the Milk River Basin of Alberta.

Populations of rare or unique species within the Milk River Basin are sensitive to human disturbance or incompatible land uses that remove, fragment or lower the quality of their habitat. Although many rare or threatened species are bound by unique habitat types such as badlands or eroded sandstone cliffs and hoodoos, others are dependent on the continuation of key ecological processes such as grazing to meet their habitat needs or ecological requirements. Prior to European settlement of the prairies, a wide range of interrelated factors including drought, fire and bison grazing shaped prairie ecosystems and created dynamic and varied landscapes. Attempts to mimic or sustain these types of natural disturbances are considered necessary to maintain the structure and function of prairie ecosystems, and to accommodate the diverse needs of multiple wildlife and plant species.

The objectives of the current project are as follows:

1. to provide an overview of historic disturbance regimes of importance in the Milk River Basin (Part I);
2. to review how current grazing management practices impact or potentially serve certain ecosystem processes (Part I and II);
3. to review key grazing management principles and provide a description of seven grazing systems that are suited for use in the Milk River Basin (Part II);
4. to summarize known ecological and habitat requirements for select management species in the Milk River Basin (Part III);

5. to evaluate range management systems for their relative value in providing habitat for select management species (Part III); and
6. to provide a summary of beneficial management practices for Milk River Basin select management species (Part III).

The purpose of this report is to develop guidelines to assist with the design of stewardship activities within the Milk River Basin as part of the MULTISAR project. An assessment of grazing processes and available management practices within the context of historic disturbance regimes and multiple species needs, provides a foundation from which to design appropriate habitat conservation strategies.

This document provides background information on the ecological and habitat requirements of 28 select management species within the Milk River Basin. These species are considered either individually or as management groups of species with similar ecological requirements. The beneficial management recommendations in Part III of this report encompass appropriate land use and grazing management strategies to maintain or enhance habitat for these species and to avoid or minimize impacts during sensitive periods. The recommendations were derived from a literature review of the limiting factors, habitat needs and ecology of each species, knowledge of grazing management, and consultation with species and range management experts. For most species, the recommendations can be applied to the full extent of their range within the Grassland Natural Region of Alberta. A synthesis of beneficial management practices is provided at the conclusion of Part III.

It is important to stress that the recommendations provided in Part III of this report will be subject to ongoing revision based on new information, monitoring and evaluation, and feedback from interested parties or agencies. Consequently, this report should be considered a "living document" subject to an adaptive management process of review and improvement.

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1 PROJECT OVERVIEW

The fauna and flora of the Milk River Basin have evolved in response to natural processes such as fire and native herbivore grazing as well as aboriginal manipulation of the environment. The underlying assumption of many range management practices is that techniques that best mimic local natural use patterns will be beneficial for native flora and fauna. This assumption is based on the theory that native flora and fauna are physiologically or behaviourally adapted to suit certain evolutionary disturbance regimes.

Part I of this report provides an overview of historic natural disturbance processes and reviews how current grazing management practices impact or potentially serve certain ecosystem processes. In Part II, a description of key grazing management principles is given in addition to a description of seven grazing systems that are suitable for use in the Milk River Basin. Part III of this report provides a description of the ecological and habitat requirements and corresponding beneficial management practices (BMPs) for 28 select management species in the Milk River Basin. These species are considered either individually or as management groups of species with similar ecological requirements. The main emphasis of Part III of the report is to assess the pros and cons of grazing and various grazing systems for maintaining or enhancing critical habitat for each species. The BMP recommendations developed for each species or species group address advantageous grazing practices as well as other land stewardship and habitat enhancement strategies. BMP recommendations were derived from a review of the limiting factors, habitat needs and ecology of each species, knowledge of grazing management, and consultation with species and range management experts. A synthesis of recommendations is provided at the conclusion of Part III. The BMPs described in this report will be subject to ongoing review and evaluation based on new information, monitoring of ongoing stewardship programs, and feedback from interested parties or land management agencies.

The purpose of this project is to develop guidelines to assist with the implementation of stewardship activities within the Milk River Basin. This project is a component of the Multi-Species Conservation Strategy for Species at Risk in the Milk River Basin (MULTISAR). MULTISAR is a joint initiative coordinated by Alberta Sustainable Resource Development (SRD), Fish and Wildlife Division and the Alberta Conservation Association. A more detailed description of the objectives of this initiative can be found in the Year 1 Progress Report for the MULTISAR project (Quinlan *et al.* 2003).

2 STUDY AREA

The Milk River Basin occupies an area of approximately 6,776 km^2 in southern Alberta, extending north from the United States border along the Saskatchewan border to Cypress Hills Provincial Park and west to Whiskey Gap. The North Milk and Milk Rivers flow within the basin toward the Gulf of Mexico. The Milk River Basin contains a diversity of landscapes including badlands, plains, uplands and valleys. Badlands can be found in the downstream section near Lost River. Unique eroded sandstone cliffs and hoodoos characterize many areas along the valleys of the Milk River and its tributaries.

The Milk River Basin is located within the Grassland Natural Region and contains areas of the Dry Mixedgrass, Mixedgrass, and Foothills Fescue Natural Subregions (Strong and Leggat 1992). The Dry Mixedgrass Subregion occupies the majority of the drainage basin and is composed of shortgrass species, such as blue grama *(Bouteloua gracilis),* and mid grasses like western wheat grass *(Agropyron smithii)*, June grass *(Koeleria macrantha)*, and spear grass *(Stipa spp.)*. The Mixedgrass Subregion is restricted to the northeast corner of the basin near the Cypress Hills and in the south central area north of the Sweet Grass Buttes. This subregion has a slightly moister and cooler climate than the Dry Mixedgrass Subregion, and contains similar vegetation but with a larger proportion of western porcupine grass *(Stipa curtiseta)* and northern wheat grass *(Agropyron dasystachyum)*. The Fescue Subregion receives the greatest precipitation and makes up a small percentage of the basin's total area. It occupies an area to the west including the Milk River Ridge and portions of Cypress Hills Provincial Park. Fescue grassland communities are dominated by rough fescue *(Festuca scabrella),* Idaho fescue *(Festuca idahoensis),* Parry's oatgrass *(Danthonia parryi)* and intermediate oatgrass *(Danthonia intermedia)*.

Cattle production is the primary land use in the Milk River Basin. Three large provincial grazing reserves (Pinhorn, Sage Creek and Twin River), an Agriculture and Agri-food Canada research substation (Onefour), as well as numerous grazing leases, preserve some of the native grasslands within the basin. Approximately 30 percent of the basin is cultivated, with the majority of cultivation around the town of Milk River. Oil and gas development activity (*i.e.,* exploration, drilling *etc*.) is present throughout the basin, with drilling activity apparently on the increase. Several ecological reserves also occur within the study area including Writing on Stone Provincial Park, portions of Cypress Hills Provincial Park, the Milk River Natural Area, and Kennedy Coulee Ecological Reserve.

3 METHODS

A thorough literature review was conducted to compile published scientific literature and unpublished reports pertaining to natural processes, grazing management, and ecological and habitat requirements for the 28 select management species. Where possible, information specific to the Milk River Basin was obtained. Subject searches were done primarily using the *Agricola* and *Biological Abstracts* databases as well as information available from SRD libraries and websites. Professional experts in the fields of range ecology and wildlife biology were contacted to provide current information.

The Habitat Suitability Index (HSI) Models that were developed as part of the MULTISAR project (Downey *et al.* 2004) helped in identifying key habitat requirements for the select management species. HSI models were prepared for fifteen of the species considered in this report including the ferruginous hawk (*Buteo regalis*), prairie falcon (*Falco mexicanus*), sharp-tailed grouse (*Tympanuchus phasianellus jamesi)*, burrowing owl (*Athene cunicularia*), loggerhead shrike (*Lanius ludovicianus*), Sprague's pipit (*Anthus spragueii*), olive-backed pocket mouse (*Perognathus fasciatus*), American badger (*Taxidea taxus taxus*), Richardson's ground squirrel (*Spermophilus richardsonii*), prairie rattlesnake (*Crotalus viridis viridis*), short-horned lizard (*Phrynosoma hernandesi hernandesi*), plains spadefoot toad (*Spea bombifrons*), great plains toad (*Bufo cognatus*), western small-footed bat (*Myotis cilolabrum cilolabrum*) and the Weidemeyer's admiral butterfly (*Limenitis weidemeyeriii*). HSI models for the swift fox (*Vulpes velox*) and long-billed curlew (*Numenius americanus*) were not included in this report as they were still in the preliminary stages of preparation and review at the time of writing.

The 28 select management species included in Part III of this report were chosen during the early stages of the MULTISAR initiative based on certain selection criteria (Quinlan 2004). The primary criteria for species selection included:

1. *strong representative of a group of species with similar habitat associations;*
2. *strong association with a specific major ecosystem (e.g., native grasslands);*
3. *strong association with specific habitat structures (e.g., cliffs);*
4. *narrow ecological tolerances;*
5. *high sensitivity to habitat changes and human activities; and*
6. *value as a "keystone species" (e.g., important prey species).*

Selected species included those listed as "At Risk", "May Be At Risk" or "Sensitive", as well as priority game species and ecologically important species in the Milk River Basin.

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PART I: NATURAL PROCESSES OF THE MILK RIVER BASIN

1 OVERVIEW OF NATURAL PROCESSES

The grasslands natural region of Alberta occupies approximately 9.7 million hectares (24 million acres) of land, of which nearly 43% remains as native prairie (Prairie Conservation Forum 2000). Dry Mixedgrass, Mixedgrass and Foothills Fescue Natural Subregions occur in the Milk River Basin Basin, of which the Dry Mixedgrass Subregion forms the most significant land base component (Strong and Leggat 1992). The prairie landscape as we see it today has been forming for millennia. The topographic and physical characteristics have their origins in the last glaciation. The development of the landscape was influenced by the advance and retreat of several glaciations, the most recent being the Laurentide Glacier, and the erosion and deposition processes that took place following this period. The pattern and type of soils and associated vegetation that have since come to dominate the prairies is largely the result of periodic drought, flood, fire, large and small herbivore grazing and predators.

Grasslands exist as a result of natural causative agents that affect an area to favour grass or grass-like vegetation. Grasslands evolved in response to several natural agents, acting singly or, more likely, collectively. Climate, topography and wind, large ungulate herds and fire are often cited as primary natural agents favouring grasslands over woodlands. The survivability of certain vegetation or community types is likely the result of these species to adapt to a historical disturbance regime. Although the size, intensity and return interval of disturbance prior to European settlement is largely unknown, scientific and cultural knowledge indicate that natural variation was great (Bradley and Wallis 1996).

1.1 Fire

Fire is an important ecological process in terrestrial ecosystems, limiting encroachment by woody species, facilitating plant community renewal by removing excess dead plant material and recycling nutrients. Under protection from fire, areas that have historically consisted of grassland or open prairie savanna have experienced an increase in the cover of woody vegetation (Bailey and Wroe 1974, Vogl 1974, Bock and Bock 1984). The advance of woody species in previously grassland dominated regions is evidenced in the photographic records from near the turn of the century, historical accounts and biosequence (grassland to wooded types) of soils (Baumeister *et al.* 1996, Dormaar and Lutwick 1966).

The historic fire return interval for fescue prairie is estimated to be 5-10 years (Wright and Bailey 1982, Arno 1980). The availability and continuity of fuel, topography and climatic (mostly wind) conditions determine the propagation of fire and its behaviour on the prairie landscape (Pyne *et al.* 1996). Prairie fires would have varied in intensity and size depending on these factors. Historical accounts indicate that prairie fires often burned for days and single fires covered huge areas, running for 100 to 200 km or more (Nelson and England 1971, Higgins 1986).

Many plant communities require fire to rejuvenate growth and return species composition to an earlier seral stage (Wright and Bailey 1982). In areas where the rate of litter accumulation exceeds decomposition with plants curing and dying back each year, fire acts as a mechanism for accelerating the recycling of nutrients into the soil. Prairie landscapes, as influenced by historical fire and bison grazing events, existed as a mosaic of seral communities (transitory stages of plant community development), each with unique disturbance histories.

Grasslands in the drier regions of the Great Plains are maintained by climatic factors, whereas at the fringe of grassland and forest ecotones, a combination of fire, drought and grazing/browsing serve to determine the type of vegetative cover (Coupland 1992). Since common woody species such as aspen (*Populus tremuloides*) and buckbrush (*Symphoricarpos occidentalis*) sprout vigorously following fire, occasional fire events alone would not control shrub cover. Extensive browsing of woody shoots by bison as well as wallowing, trampling and toppling of trees by rubbing against them likely contributed significantly to the suppression of aspen growth on the prairies (Campbell *et al.* 1994).

Changes in the composition of fescue prairie as a result of fire have been primarily attributed to an altered microenvironment, particularly moisture regimes (Romo 1996). Burning mostly shifts the environment in fescue prairie from one with light limitation to one that is water limited. Grasses adapted to drier environments are favoured over species adapted to more mesic environments. Annual spring burning in the parkland causes a shift from species of the fescue prairie towards a mixedgrass prairie association (Anderson and Bailey 1980). The persistence of these drier conditions is dependent on the severity of the fire and the climatic conditions following the fire event. Under favourable climatic conditions, the recovery of burned fescue prairie to pre-burn composition and production may only require a few years (Joudannais and Bedunah 1990, Redmann *et al.* 1993).

Fire has important ecological effects on vegetation composition and structure, including productivity, insect populations and soil properties (Kerr *et al.* 1993). Fire favours vegetation that is adapted to periodic removal of above ground growth. Fire commonly favours forbs over grasses in grasslands (Daubenmire 1968, Antos *et al.* 1983, Bailey and Anderson 1978). Plant species diversity may increase by removing litter from areas that have heavy accumulations. Excessive litter build up can be detrimental to seeding establishment of some species. In the fescue prairie, large bunches of rough fescue are more seriously damaged by fire than smaller bunches, indicating these plants are adapted to shorter intervals between fires or disturbance which limit the expansion in plant diameter (Antos *et al.* 1983). Fescue grasslands are generally resistant to fire, as single defoliation events following fire do not have a detrimental effect on rough fescue (Bogen *et al*. 2003). This resistance is likely facilitated by reduced production in rough fescue plants after fire, which diminishes the value of grazing especially with regard to the increased risk to the plant with subsequent grazing.

Historical records of lightning-set fires are rare compared with the accounts of Native American-set fires (Higgins 1986). Higgins (1984) found that on average 6-24 lightning fires per year per 10,000 km^2 occurred in the mixedgrass prairie during a period from 1940-1981. The majority of these fires occurred in July and August. In more mesic environments, the incidence of lightning caused fire may be less significant. In Yellowstone National Park, for example, lightning strikes on average 4 times per km^2/year, but has not initiated a single fire in the northern range despite an abundance of available fuel (Kay 1995). This is likely because when conditions are conducive to lightning strikes, the herbaceous vegetation is too green to carry a fire.

Historically, aboriginal burning occurred in every month of the year except January (Higgins 1984).

1.2 Native Americans

Fire caused by Native Americans differs from lightning fire in terms of seasonality, frequency, severity and ignition patterns (Kay 1995). Aboriginal fires were mostly set in spring, between snowmelt and greenup, or late in the fall at a time when burning conditions would not create as severe effects as those caused by lightning fires during dry periods (Kay 1995). Whereas lightning fires tend to be infrequent and intense, native burning during these periods was more frequent, but produced a lower intensity fire. The impact of native burning on plant communities was undoubtedly great, contributing to the formation of the mosaic of vegetation types on the prairie that were prevalent at the time of European settlement.

It is suggested that where precipitation is sufficient to support the growth of trees, grasslands were of anthropogenic rather than climatic origin (Denevan 1992). However, other climatic and topographical factors influence the persistence of parkland or forested vegetation. Burning at the grassland-forest transition will create drier conditions favouring grassland, pushing back the forest edge. Some regions of the prairies may have been maintained only through nearly annual burning by Native Americans during the last 5,000 years (Anderson 1990). Native Americans were active landscape architects, using fire extensively to manipulate the plant community and distribution of game (Dormaar and Barsh 2000). Fire was used by Native North Americans to modify the plant community to maintain, for example, patches of naturally occurring medicinal and food plants such as camas and wild turnip, and many other cultural and inter-tribal relation reasons (Kay 1995). The nomadic nature of tribes influenced the occurrence of useful medicinal and food plants by the collection of plants from certain areas and cultivation by transplanting shoots or runners.

Native Americans also had the capability to influence the ungulate population through hunting, which in turn would influence the native prairie. Lewis and Clark (1893) noted that "with regard to game in general, we observe that the greatest quantities of wild animals are usually found in the country lying between two nations at war." Aboriginal hunting tended to extirpate or drive out game animals, and resource depletion around camps and villages has frequently been reported in studies of modern hunter-gatherers (Kay 1995).

1.3 Bison

Herds of bison (*Bison bison*) on the northern Great Plains distributed themselves in response to variable climatic factors, fluctuations in the quality and quantity of available forage, availability of water and hunting pressure. The number of bison in North American has been estimated at 40 to 60 million animals by Seton (1929) based on assumptions regarding carrying capacity, range area, habitats and population trends. The migratory nature of bison makes it difficult to estimate the population that existed in western Canada. From historical accounts of western Canada's early explorers, individual bison herds would have ranged in the thousands, and millions were likely present on the grasslands of western Canada at any given time (England and DeVos 1969). Undoubtedly, their impact on the landscape was significant. Larson (1940) suggested that their presence in the short grass prairie maintained that plant community in a state of disclimax and without bison overgrazing the community would likely be more representative of mixedgrass prairie.

Although bison overgrazing was prevalent throughout the prairies, their transient nature would have likely resulted in large herds not returning to these areas for several years. Bison may also have demonstrated what Epp (1988) refers to as a "dual dispersion strategy" having both migratory and non-migratory herds. River valleys, parklands, ranges of hills and sandhills with abundant water may have been inhabited by small sedentary herds of bison, which fed in nearby grassy uplands (Epp 1988). Bison may have also remained on the plains during mild winters (Moodie and Ray 1976).

It is generally believed that bison migration was from the mixedgrass prairie of the northern Great Plains to the fescue prairie in the foothills and parkland in Alberta and similar regions in Saskatchewan and Manitoba with the onset of winter (Moodie and Ray 1976, Morgan 1980). In early autumn soon after the summer rut, large herds of plains bison split into smaller units and migrated to wintering grounds. However, other views have challenged this notion, suggesting that bison movements were erratic, only governed by the availability of food (Hanson 1984).

Based on a preference of fescue prairie for wintering by bison, movement to the foothills and parkland was likely driven by three fundamental energy requirements to survive the winter: 1) deposit fat reserves prior to the onset of winter; 2) utilize a winter diet of adequately high energy forage and 3) take advantage of protein-rich, early spring forage growth (Baumeister *et al.* 1996). Rough fescue (*Festuca campestris*), the characteristic grass of the fescue prairie, initiates spring growth approximately one month earlier than dominant mixedgrass prairie species such as blue grama (*Bouteloua gracilis*). Early spring growth is typical of most cool season grasses and providing soil moisture is sufficient enough, additional growth may occur in the fall (Stout *et al.* 1981). This lends to the adaptation of rough fescue grassland to grazing during dormant periods. Repeated defoliation of rough fescue during the growing season can be detrimental, resulting in reduced yields, vigor and eventual elimination of plants from the community (Willms 1988, Willms and Fraser 1992). In comparison, mixedgrass communities may be more resistant to grazing during the growing season based on the historic use pattern of these ranges. Repeated defoliation at a moderated utilization level throughout the growing season generally does not negatively impact species composition in mixedgrass communities (Biondini *et al.* 1998).

Selective use of habitats or plant species by large herbivores can influence plant populations, diversity and community structure, and ecosystem processes (Vinton *et al.* 1993). The opportunity for selective grazing within plant communities in the northern Great Plains by immense migratory bison herds was likely low. Rather, the forage supply would have been completely utilized before the herd moved on as indicated by accounts in the journals of early explorers. Where vast herds of bison had passed, the ground was completely denuded of vegetation leaving little or no forage available for the explorers' horses (Nelson 1973). However, where sedentary herds existed, there would be a greater opportunity for selective grazing and regrazing of more favourable forage.

Bison behaviour and activity, besides grazing, also influenced the structure and composition of grasslands. Wallowing, pawing, trailing and other similar non-grazing bison activity creates micro-environmental effects that increase heterogeneity on the landscape. These small changes on the landscape increase the diversity of environmental conditions plants are able to take advantage of and potentially increase overall species richness (Hartnett *et al.* 1997).

Although cattle, as large grass-feeding herbivores, may be able to fulfill the same ecological function as bison, there are inherent differences in their grazing behaviour. Cattle grazing patterns are influenced by slope, as well as horizontal and vertical distance from water, regardless of forage availability (Van Vuren 1982). Cattle use a significant lower percentage of upland habitat compared with bison and tend to favour floodplain habitat. Forage availability appears to be the only factor affecting bison distribution as rugged terrain seldom impedes their movement and they will travel considerable distance from water, spending less time at a water source. Bison are far more efficient water users than cattle and can better utilize lower quality, drier forage (Wuerthner 1998). The construction of fences, stockwater supplies and other developments undoubtedly alter bison and cattle foraging behaviour alike compared with the natural wanderings of large bison herds.

1.4 Other Wildlife

The Great Plains are described as teeming with abundant game in historical accounts of Pre-settlement times. Nelson (1973) describes the early explorers' accounts of the variety of species such as bison, elk (*Cervus elaphus*), antelope (*Antilocapra americana*), wolves (*Canis lupus*) and cougars (*Felis concolor*) as common in their thousands and millions, along with a multitude of birds. The area around Cypress Hills was likened to parts of Africa where the plains were swarming with animal life of all kinds.

Antelope numbers were estimated to be as numerous as the bison (Rand 1945). The historical range of antelope extended to the North Saskatchewan River east into Manitoba and northwest to Rocky Mountain House, Alberta (England and Devos 1969). There is little account of the slaughter of antelope to the excess experienced by the bison during the same period, but their numbers decreased greatly. This may be due to a loss of suitable habitat with the extirpation of bison herds. The diet of antelope consists largely of forbs and browse and the abundance of suitable forage would have largely been dependent on grazing by bison herds and fire to favour these plant species. The demise of large antelope herds may have been linked with the extirpation of the bison as well as the construction of barbed wire fences and other obstructions to antelope movement with the onset of European settlement.

As a result of long-term control measures and other human activities, several species of carnivores have been extirpated from rangelands of North America (Jones and Manning 1996). These include species such as wolves, black bears (*Ursus americanus*), grizzly bears (*Ursus arctos*) and cougars. Conversely, species such as coyotes (*Canis latrans*) and badgers (*Taxidea taxus*) now inhabit areas that were not used by them historically (Jones and Manning 1996). Carnivore predation, in addition to native hunting, may have influenced ungulate populations and distribution. According to predator-prey theory, prey populations will increase if they have a refugium where they are safe from predation (Taylor 1984). By undertaking long-distance migrations, bison were able to outdistance most of their carnivorous and human predators (Kay 1995).

The abundance and influence ungulate species other than bison had on the prairies is questionable in some regions of western North America (Kay 1995), but the influence of the beaver (*Castor canadensis*) in shaping the landscape of western Canada is significant. Where humans wielded fire, beavers controlled the water. While beaver were commonly found along mountain streams, large numbers also inhabited water courses on the prairies (Kay 1995). It is suggested millions of beaver inhabited western North America before the fur trade (Johnson and Chance 1974). Beavers continually dammed up streams and rivers often causing new water courses to be formed. Changes in drainage patterns had distinct influence on vegetation and likely attracted other animals, such as moose and ducks, to the area. Beaver are not nearly as common as they were prior to European settlement and are even considered ecologically extinct in regions of western North America (Kay 1995).

Small burrowing mammals may have also contributed to the structure and function of the native prairie. The black-tailed prairie dog (*Cynomys ludovicianus*) is the most widespread of the prairie dog species in the mixedgrass and shortgrass prairies of the Great Plains (Hoogland 1995). Pre-settlement distribution and abundance is largely unknown, but lands currently occupied by prairie dogs are thought to represent less than 10% of their historical range (Anderson *et al.* 1986). Prairie dogs likely inhabited the Milk River Basin at one time, but their distribution in Canada is presently restricted to extreme southern Saskatchewan. Prairie dogs can have large and significant effects on plant productivity, community dynamics and nutrient cycling (Whicker and Detling 1988) similarly, though not equal, to the effects of other burrowing mammals on the prairie. Prairie dogs are principally herbivores and their grazing activities tend to increase the abundance of forbs in the vicinity of established colonies. These modified habitat conditions likely affected the distribution, at least on a regional level, of other foraging animals such as antelope and bison (Stapp 1998). Burrowing activities that affect nutrient cycling and other associated ecosystem processes thereby may also modify soil micro-climate and plant production. The effects prairie dogs and other small mammals have on the ecosystem tended to increase the overall diversity and promote functional integrity of native grassland communities (Stapp 1998).

1.5 Implications for Ecosystem Management

Prairie species evolved in response to certain level of disturbance and many plant communities became dependent on disturbance for their regeneration or survivability (Bradley and Wallis 1996). These disturbances occurred in such a manner that promoted biodiversity while maintaining high productivity sustaining large ungulate populations. For example, more diverse plant communities are more resistant to and recover more fully from a major drought (Tilman and Downing 1994). Native prairie is in a state of dynamic equilibrium, self-sustaining and resilient to disturbance within the natural range of variation. The stability of long-term primary production in prairie ecosystems is dependent on the maintenance of biodiversity (Tilman and Downing 1994).

Although it is neither feasible nor practical to manage for all components of the ecosystem, striving for ecological integrity through promotion of biodiversity and sustained function (*e.g.,* grass production) is a principle of ecosystem management. Objectives of current range management tend to be uniform distribution of use with moderate grazing pressure. These management techniques strive to maintain the health of native prairie and avoid degradation of areas where livestock may congregate, such as riparian habitats. Most grazing systems are applied with moderate grazing pressure that permit selective grazing and the creation of overgrazed and undergrazed patches. Patchy grazing contributes to landscape heterogeneity, but it is usually within fields on a small scale (*i.e.*, small patch size). Grazing systems can be used that allow the creation of planned heterogeneity on a larger scale by controlling the grazing pressure and time of grazing within fields.

By allowing natural processes, such as erosion/deposition, drought, flood, fire or herbivory to occur on the landscape or by approximating them through management, it is assumed there will be a better chance of preserving biodiversity and sustaining ecosystem processes (Bradley and Wallis 1996). Patchy grazing on a large scale, with lightly, moderately and heavily used areas may be desirable. These patterns of livestock use appeal to a greater variety of plant and wildlife species. However, these practices applied on a smaller scale may not produce varying plant communities significantly large enough to be effective habitats for certain species. It may be more effective in some cases to create heterogeneous communities between fields on a landscape level. Range management that over-intensifies or homogenizes grazing consistently across the landscape will tend to reduce the range of natural variation. Specialized grazing systems can create a mosaic of grass cover types to satisfy a diversity of animal species, while still accommodating livestock grazing.

Prior to agricultural settlement, a wide range of interrelated factors such as drought, fire and bison grazing created dynamic and varied landscapes. This likely included extremes in environmental conditions from highly impacted areas (due to grazing, fire or drought, for example) to areas of low use. These extremes are largely absent from the present day landscape, but may have been very important to vegetation and wildlife dynamics. A better understanding of missing features and natural processes on ecosystem health may be required for prairie conservation.

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PART II: GRAZING MANAGEMENT

1 OVERVIEW OF GRAZING MANAGEMENT

1.1 Principles

Range management is referred to as the art and science of producing sustained yields for livestock and wildlife while maintaining ecosystem integrity for a variety of purposes (Society for Range Management 1998). Proper range management leads to increased livestock production, and improved watershed and ecosystem stability (Holechek *et al.* 1995). To achieve these results, the four basic principles of range management must be followed (Wroe *et al.* 1988, Grazing and Pasture Technology Program 1995):

1. Graze range at the right time of year and leave adequate leaf area to ensure regrowth by balancing the number of animals with the available forage supply.
2. Use the kinds of livestock most suited to the forage supply and objectives of management.
3. Allow each range unit a period of rest from grazing animals during the active growth season to manage and maintain the vegetation.
4. Control livestock distribution and access to minimize selective grazing behaviour and prevent regrazing of plants.

Planning for the current grazing system involves evaluating the past grazing season. Understanding the growth of plants and how grazing management affects growth is basic to range management. The amount of new spring growth depends on the amount of energy stored the previous season. Energy or carbohydrate (food) reserves of perennial plants will be at their seasonal lows soon after early spring growth starts.

1.2 Proper Use Factor

A proper use factor is the percentage of utilization for a plant species or range deemed acceptable to allow improvement or maintenance of range condition (Grazing and Pasture Technology Program 1995). Proper use factors are useful but difficult to apply because they do not deal with repeated defoliation of individual plants. Plant species also vary in their resistance to grazing. Certain species can easily sustain themselves with 70% utilization, while other species may only tolerate 20% removal during the growing season. The range management rule of thumb was once considered to be “take half and leave half” for current year’s forage growth. This rule is now being brought into question, as the understanding of how plants grow and how they respond to defoliation is increased. A low proper use factor does not necessarily eliminate overgrazing. Certain areas are more attractive for grazing such as riparian areas and may receive 100% utilization, while other areas (*e.g.,* uplands) remain unused.

Using the correct grazing system to meet grazing, wildlife, and vegetation enhancement objectives can help determine the proper use factor to be applied to these systems. However, the implementation of a specialized grazing system does not ensure that range deterioration will not occur. Stocking rate, within the context of climatic conditions, is and always will be the major factor affecting the condition of the rangeland resource (Hart *et al.* 1993, Holechek *et al.* 1995).

1.3 Grazing Distribution

Implementing a grazing system usually requires some degree of fence construction or intensive management to manipulate livestock distribution. Depending on the environment and the landscape, other distribution tools (supplement locations, water development) may effectively fulfill the same management objectives without additional fencing. However, most of these distribution tools work best in conjunction with grazing systems to increase their effectiveness. Distribution of livestock on the range is affected by different types of vegetation, soils, slopes, terrain, weather, supplements and, most importantly, water (Springer 1998). One of the greatest challenges to managing any grazing system is to overcome the tendency of livestock to overgraze preferred areas. Over time, grazing may result in poor condition and lost grazing opportunities (Robertson *et al.* 1991).

The carrying capacity for a grazing unit is the average number of livestock and/or wildlife that may be sustained based on the management objectives for that unit (Society for Range Management 1998). Without effective livestock distribution, grazing is generally confined to preferred areas, reducing grazeable land area and consequently reducing stocking rates. This lower stocking rate is often referred to as the grazing capacity and reflects a need for better range management (Robertson *et al.* 1991). Improvements in range condition and achieving the carrying capacity for a grazing unit is reliant on increasing overall utilization of the field through manipulating livestock distribution.

Considering the number of multiple uses that can occur on a particular landscape, a homogenous plant community may not be the appropriate range management goal. Wildlife species respond to a variety of range conditions and plant community structural characteristics. This variety may be created within a field or between grazing units. However, to obtain improvements in range conditions the simplest method is often to improve livestock distribution.

Poor water distribution is often the main cause of uneven grazing distribution. In the interest of livestock gains and movement across the field, the following guidelines for maximum travel distance to water, taking terrain into account, are as follows (Springer 1998):

Rough country	0.5 miles (800 m)
Rolling, hilly country	1 mile (1.6 km)
Flat country	2 miles (3.2 km)
Smooth, sandy country	1.5 miles (2.4 km)
Undulating, sandy country (dunes)	1 mile (1.6 km)

Climatic conditions will also affect these distances. In cooler areas and cooler seasons, livestock may walk longer distances to water with no adverse effects on weight gain (Springer 1998).

Terrain may also form barriers to livestock movement, restricting access to benches and ridge-tops, and concentrating use along valley bottoms and lowlands. Promoting livestock use of uplands is usually further compounded by the presence of water below the toe of the slope. The degree to which livestock will utilize slopes largely depends on the class and age of livestock. Several sources cite different points at which steepness of the slope becomes too great for livestock to utilize, including 10% (Holechek *et al.* 1995), 15% (Robertson *et al.* 1991, Grazing and Pasture Technology Program 1995) and 20% (Springer 1998) slopes. Development of watering points at shorter intervals helps to minimize uneven grazing in rough country (Springer 1998). The reluctance of livestock to use steep slopes is not entirely undesirable since these areas are often fragile and valley bottoms can typically better withstand grazing (Holechek *et al.* 1995).

Livestock will seek out vegetation that best meets their nutritional needs (Holechek *et al.* 1995, Springer 1998). Seasonal preference for different plant community types is closely associated with the relative crude protein content of standing forage. For example, in the mixedgrass prairie cattle prefer vegetation types dominated by western wheatgrass and blue grama in the spring and summer (Holechek *et al.* 1995). In the fescue prairie, range types dominated by rough fescue are preferred in the summer and winter (Willms and Rode 1998). Fencing based on vegetation units will improve the overall utilization of those units. Where feasible and practical, fences should separate hillsides from lowlands, brush or forest cover from grassland, and native pasture from seeded pasture (Robertson *et al.* 1991).

Distribution of grazing may also be directly affected by weather. Warm weather will force livestock to congregate on north facing slopes, shaded areas, and higher elevations, whereas cold weather will cause animals to graze south facing slopes. Cattle also generally travel in the same direction as a cold wind in an attempt to reduce its chilling effects. Insects can drive cattle to higher ground where wind may reduce biting and irritation.

Properly placed salt, mineral or supplemental feed can be an effective tool to manipulate livestock movement. Livestock usually go from water to grazing and then to salt (Holechek *et al.* 1995). Therefore it is not necessary to place salt at watering points and is inadvisable to do so. Where salt content in plants and soils is high, the placement of salt in certain areas to attract cattle may not be effective (Springer 1998).

Herding livestock within a field may be used to improve distribution. Herding may be more effective where livestock are driven from lowlands to upland benches and ridges that have available water. These areas will then be more readily utilized once livestock have become aware of available forage even though steep terrain may inhibit access. Upon entering a field, livestock will tend to congregate at the gate through which they traditionally use. By continuing to herd cattle through the field to an alternate area of available water and forage, this habit may be overcome. Changing the point of entry can also change this pattern.

1.4 Biodiversity

The overriding mechanism for change in plant communities of the native prairie is climate. Fire, insects, grazing and other physical disturbances influence change within the context of climatic conditions (Clark *et al.* 1947, Hurtt 1951, Reed and Peterson 1961, Olson *et al.* 1985, Hart *et al.* 1988, Biondini *et al.* 1998). That is to say, weather patterns ultimately determine plant species composition with grazing and other disturbances playing a secondary role. When grazing pressure does not exceed 50% utilization of the current year's growth in the mixedgrass prairie, grazing frequency tends to have a minimal impact on relative species composition (Biondini and Manske 1996). Therefore, a grazing pressure of 50% of the current year's growth appears to be sustainable and compatible with the maintenance of range condition in the mixedgrass prairie.

Protection from grazing in fescue grassland tends to simplify the flora, whereas light grazing results in the development of richer flora dominated by Parry oatgrass (*Danthonia parryi*) (Johnston 1961). Grazing systems that maintain good range condition tend to promote optimum biodiversity (Bai *et al.* 2001). There is an intermediate point of range condition as influenced by grazing pressure at which species richness is maximized. Structural parameters, such as cover, height or thickness of standing plants (live or dead) and litter, increase with range condition (Bai *et al.* 2001). In terms of structure, the diameter of bunchgrasses decreases when the prairie is utilized (Johnston 1961, Moss and Campbell 1947).

1.5 Ecological Site Dynamics

An ecological site is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation (Range Health Task Group 2002). Plant communities for an ecological site are dynamic, responding to changes in environment and disturbances by adjusting the kinds, proportions and amounts of plant species in the community (Butler *et al.* 1997). Climate, soil and topography are the major factors that interact to produce a distinctive climax plant community. The climax plant community is that which would exist under light to no grazing (or other major disturbance). It is a relatively stable balance of plant species having evolved under a certain historical disturbance regime (fire, bison grazing, drought, *etc.*). These species are adapted to their surroundings and survive within the environmental limitations of the area.

It is necessary to understand the ecological site within the context of the historical disturbance and climatic regime to interpret the effects of management practices used on the rangeland. Many complex factors contribute to change in the composition, function and trend of plant communities. Individual species or groups of species in a plant community respond differently to the same disturbance pattern or stress. Specific species may be severely affected by improper use or stress during their critical growth period, but tolerant at other times.

1.6 Establishing Management Objectives

Management objectives that are compatible with the needs of the landowner, the resources and the long-term viability of species biodiversity and wildlife habitat must be determined. Before any management system can be implemented, present vegetation condition and health as well as the desired plant community must be identified. Knowledge of the range resource base assists in focusing and formulating realistic management goals and facilitates the implementation of an effective management plan. Defining management objectives makes it possible to develop strategies directing the desired change in the soil-plant-animal complex. The desired plant community may achieve a number of management objectives within the criteria of maintaining a healthy ecosystem, conserving biodiversity, promoting water and soil conservation and providing an adequate amount and quality of forage for livestock.

2 GRAZING SYSTEMS

Grazing systems for native prairie are designed to manipulate livestock in a planned manner, optimizing livestock and forage production while maintaining the ecological integrity of the range through correct stocking rates and forage use levels. An effective grazing system controls timing, intensity and frequency of grazing of individual plants and improves livestock distribution. The goal of any grazing system is to allow the range to improve while it is being used. Selection of an appropriate grazing system is dependent on vegetation type, physiology of the plants being grazed, type of livestock and objectives of the manager.

Each livestock operation must develop a grazing management system tailored to its resources and objectives. Managers should have the option to combine traits from more than one grazing system to develop a system that suits their needs and goals. There is no universal best grazing system applicable to native prairie and some systems are only successful in certain environments. The implementation of a specialized grazing system does not ensure good range health. The principles of range management must still be adhered to. The success of a grazing system relies on proper stocking rates, animal distribution, proper use, and monitoring.

Many grazing systems have been developed for native prairie, each having distinct characteristics, objectives, advantages and disadvantages. Grazing systems that make use of different areas of the available rangeland at different times of the year may complement or compete with various wildlife species. The management of plant communities depends on an understanding of the ecological processes and ecology of the communities being managed for. There are several considerations to take into account before any management system can be implemented.

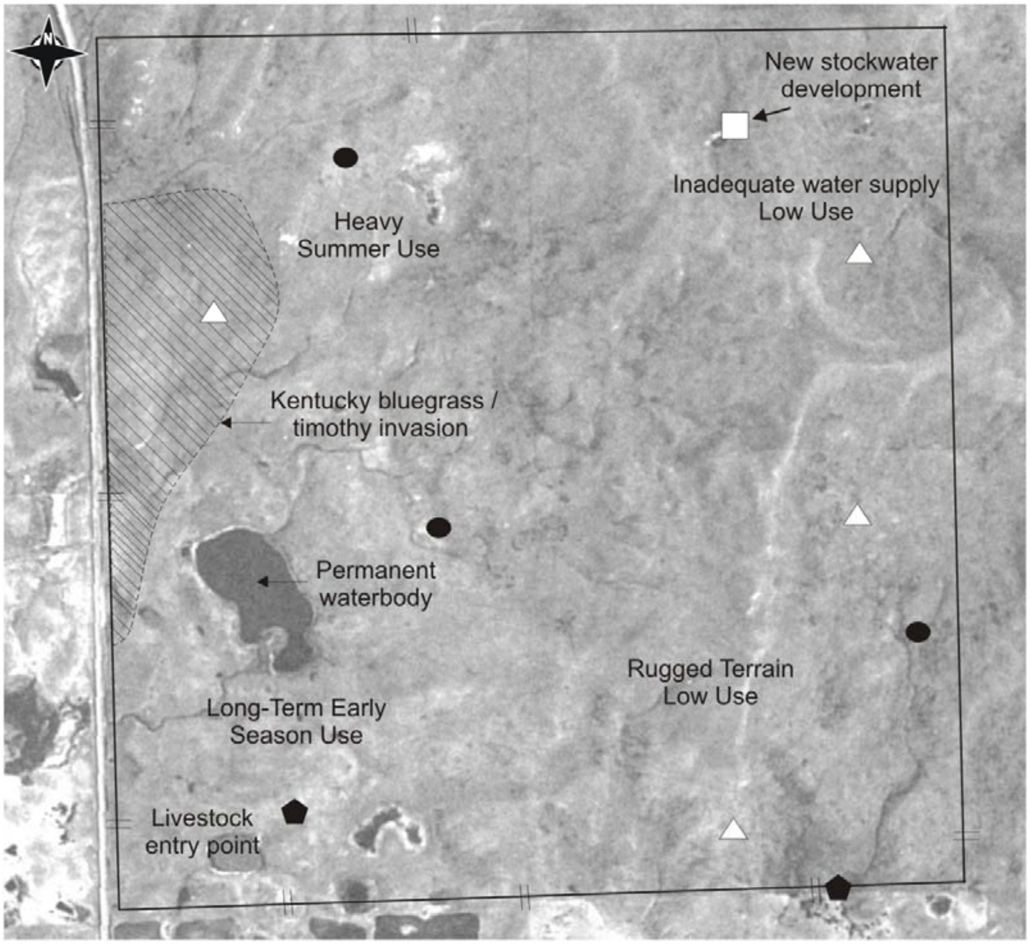
2.1 Continuous (Season-long)

Season-long grazing may be distinguished from continuous grazing in that animals are grazed on a particular pasture for only part of the year, usually the growing season. Low annual precipitation and adverse ecological conditions during the winter in south-eastern Alberta generally do not make continuous grazing year round feasible. For the purposes of this discussion continuous grazing is considered to be the same as season-long grazing.

In a continuous grazing system, livestock are held within one grazing unit or field for the duration of the grazing season. The grazing season is usually the active growing period for plants. With appropriate stocking rates and livestock distribution, range condition can be maintained under this system. Improvements in range condition may be possible through applying proper grazing pressure and correct grazing distribution and timing (Figure II-1). However, adequate grazing distribution may be difficult to achieve.

Declines in range condition are often associated with this type of system as a result of livestock continuously regrazing favoured plants and areas. Regrowth on native grasses is more palatable and nutritious to livestock than is mature initial growth available on other previously ungrazed plants. As forage matures later in the growing season, livestock gains diminish due to senescence (weathering) of vegetation. Stunted flowering stalks produced in regrowth have little or no seed for reproduction purposes and if the plants are not rested, the carbohydrate reserves will become so reduced they eventually die (Wambolt 1979).

CONTINUOUS (SEASON-LONG) GRAZING



GRAZING NOTES

A. Range Improvements

Strategic salt placement is used to improve grazing distribution. Herding cattle periodically during the grazing season is used to move cattle from areas of high to low use. Water supply is still the limiting factor in livestock movement.

B. Management Practices

The field is one section in size (640 acres or 259 ha) and the herd is approximately 100 head of cattle. Cattle begin grazing the field in May and are taken out in August. Changing the entry point for cattle in the field is used when feasible.

C. Benefits

Livestock distribution has improved somewhat due to greater management input. There is less pressure on high use areas early in the season with a change in entry points for livestock into the field. However, cattle still congregate near consistent water supplies throughout the summer.

Uneven grazing pressure throughout the field creates areas of high utilization and areas that are seldom used. This results in either poor or good (to excellent in unused areas) range conditions.

Plant and wildlife species that are able to take advantage of the two extremes in range condition benefit from this system.

Rangeland Conservation Service Ltd.
Environmental Services

Alberta SUSTAINABLE RESOURCE DEVELOPMENT

Alberta Conservation Association

LEGEND

- Fence line
- Gate
- Abandoned cultivation
- Salt
- Developed spring
- Undeveloped spring
- New stockwater development

FIGURE II-1

CONTINUOUS GRAZING USED IN THE FESCUE PRAIRIE

RCS 03-1121 | April 2004

Figure II-1: Continuous Grazing used in the Fescue Prairie

The overuse of the preferred species tends to change the species composition of the rangeland vegetation from a mixture of desirable species to an aggregation of low-producing, undesirable plants. It is often difficult to determine a proper use factor for season-long grazing systems due to the unevenness of range use and selective grazing. Livestock will utilize the preferred species heavily, while grazing less desirable plants lightly, if at all, thus allowing the inferior species to gain a growth advantage. If a proper use factor is applied only to forage species being utilized, the result is usually an underutilized range.

Continuous grazing is advantageous from a management perspective in that the level of input is minimal. The capital investment of fencing and water development is generally less than with other grazing systems. Livestock may benefit from this type of system as they are able to select each plant species at its peak nutrition when they have access to the entire grazing unit throughout the growing season. Initially, this often results in greater gains than under other grazing systems, but even with conservative stocking rates, less palatable and nutritious species will increase, decreasing the overall forage availability.

In fescue grassland season-long (mid-May to mid-November) heavy grazing results in increases in plant species that are shallow-rooted and less productive, but more resistant to grazing (Dormaar and Willms 1990) and a decline in range condition (Willms *et al.* 1985). Repeated defoliation of rough fescue during active growth reduces plant production, height, number of stems per plant, and growth rate (Willms and Fraser 1992). The frequency and time of defoliation is more detrimental to rough fescue plants than the severity of the defoliation or amount of plant material that is removed (Willms pers. comm.). Summer grazing also tends to favour Parry oatgrass, which is more tolerant of grazing, but forage production of the grassland is reduced (Willms 1991).

Season-long grazing at high stocking rates also changes soil characteristics to that of a more arid climate, reducing fertility and water-holding capacity (Dormaar and Willms 1998). However, season-long grazing at moderate stocking rates may maintain soil quality, productivity and economic returns (Dormaar and Willms 1990). With lower livestock density as compared with other grazing systems there is less risk of soil compaction.

Grasses in the mixedgrass prairie evolved with heavy bison grazing and are quite grazing resistant. Prolonged periods of overgrazing, interspersed with large-scale drought events, may be required before substantial changes in above ground net primary production (ANPP) and/or species composition can be observed (Biondini *et al.* 1998). Smoliak *et al.* (1972) found that after 20 years of varied season-long grazing pressures, the basal area of blue grama (*Bouteloua gracilis*), low sedge (*Carex eleocharis*) and little clubmoss (*Seleginella densa*) increased with increased grazing pressure, whereas, basal area of needle-and-thread (*Stipa comata*) and western wheatgrass (*Agropyron smithii*) decreased. Although the differences in species composition as a result of grazing pressure were minimal in this study, it represents the long-term trend in range condition.

Given the flat nature of the terrain in the mixedgrass prairie, and if there is close proximity of watering points, the tendency of livestock to congregate and linger in the most convenient areas is minimized, evening the grazing pressure. For example, continuous grazing at a moderate stocking rate where watering points are seldom farther than 3.2 km apart has been as effective as rotational grazing systems in terms of vegetation productivity (Smoliak 1960). On ranges deteriorated by drought, Biondini *et al.* (1998) found that ANPP was not improved with moderate or even no grazing versus heavy grazing in the short term (<10 years). Although this study found no difference in ANPP due to grazing, root biomass declined with heavy grazing implying there are long-term impacts on productivity due to grazing.

Continuous grazing usually leads to the formation of grazed patches. The occurrence of overgrazed and undergrazed areas within a field is usually the result of select grazing where forage supply exceeds livestock demand (Spedding 1971). This is characteristic of range stocked season-long at a moderate rate intended to maintain plant vigour and to allow for carryover to the following year (Willms *et al.* 1988). Grazed patches are maintained by repeated grazing of regrowth, which is preferred to more mature vegetation. Willms *et al.* (1988) found that these grazed patches are stable in the short and long-term within rough fescue grasslands and the grassland will tend to deteriorate in these areas despite a moderate stocking rate.

Patchy grazing creates heterogeneous grassland, having varied effects on the ecosystem. A more diverse habitat for wildlife may be created depending on the size of patches within the mosaic, but the ungrazed patches represent unused production. Undergrazed patches, however, also ensure the presence of climax species in the community and the potential for recolonizing overgrazed area as well as providing emergency forage during years of below average precipitation.

Negative range trends (*i.e.*, a decline in range condition and health) are generally not associated with continuous use of range in the fall and winter when plants are dormant. Year-round continuous grazing may be less harmful than other grazing systems as utilization needs to be low enough during the growing season such that sufficient forage remains during the dormant season to meet the nutritional requirements of livestock. However, the ability for the manager to adjust stocking rates in response to environmental conditions is reduced.

2.2 Season-of-Use Grazing

This system involves several fields, each receiving one grazing pass at approximately the same time every year (Abouguendia and Dill 1993). This system is well suited in cases where vegetation types differing in their season of growth are available. For example, it may be applicable in portions of the mixedgrass prairie where range units dominated by needle-and-thread (a cool-season grass) and others dominated by sand grass (*Calamovilfa longifolia*) and sand dropseed (*Sporobolus crytandrus*) (warm-season grasses) exist. The season of growth for cool-season grasses is generally late spring whereas the season of growth for warm-season grasses is in late spring and early summer (Holechek *et al*. 1995). In areas where both mixedgrass and fescue prairie grazing units are available, mixedgrass prairie may be used in late spring and early summer and the fescue dominated range may be saved for late summer and early fall grazing.

Repeated seasonal use of native vegetation is generally detrimental to the plant species that are most palatable during the period of use. Continuous early season (May through July) grazing in the mixedgrass and fescue prairie tends to increase the amount of bare ground (Naeth *et al.*

1991). In mixedgrass prairie, forbs and shrubs may be more prominent under early season grazing and grasses more prominent under late season grazing (Naeth 1985). The composition of native grasses is also affected by grazing season. Late season grazing increases frequency of taller grasses such as spear grass (*Stipa* species), wheatgrass (*Agropyron* species) and June grass (*Koeleria macrantha*).

Seeded pasture is often incorporated into a season-of-use system that is based on varying vegetation types. In this regard, the season-of-use system would be similar to complementary grazing systems. Seeded pastures often provide highly nutritious forage earlier and later than native range, and can withstand more intensive grazing.

In the mixedgrass prairie, Smoliak (1968) found that incorporating crested wheatgrass (*Agropyron cristatum*) and Russian wild rye (*Elymus junceus*) with native range use benefited both livestock and the range. Given free choice between the three vegetation units, livestock preferred to use crested wheatgrass in the spring, native prairie in the summer and Russian wild rye in the fall. This system may not be as effective as other systems in improving range condition, as this study found that forbs and shrubs increased under free-choice or continuous grazing compared with rotational grazing. The basal area of blue grama also increased under free-choice grazing, but decreased with rotational grazing.

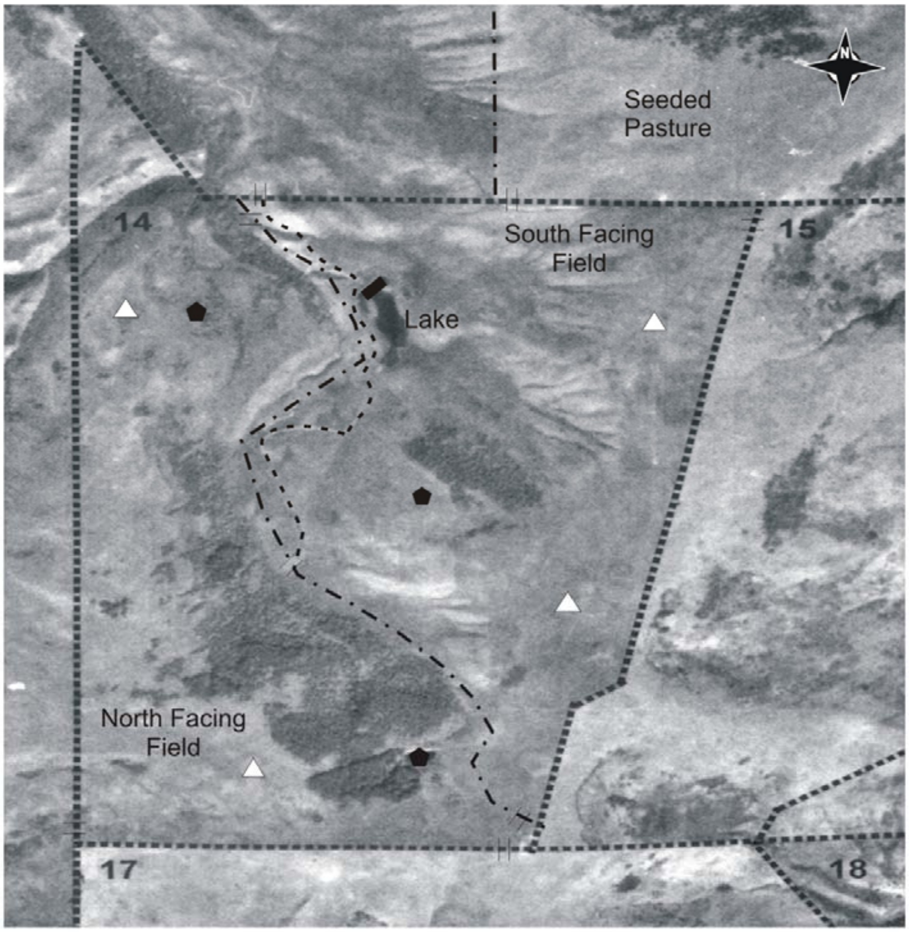
Ranges that are comprised of treed or shrubby areas (north-facing slopes), grassland (south-facing slopes) and meadow (riparian) vegetation types may be fenced and used separately to benefit vegetation, livestock and wildlife. Grassland forage species initiate growth earlier in the spring and mature earlier in the summer than do treed ranges (Holechek *et al.* 1995). Grazing different range types during their season of best use may result in overall forage quality and higher nutritional value. Figure II-2 demonstrates how a season-of-use grazing strategy may be implemented for grazing units that contain both grassland and treed or shrubby vegetation. Incorporating seeded pasture in the season-of-use strategy for this grazing unit also defers the use of native vegetation later in the growing season. Fencing grazing units based on vegetation has the added benefit of controlling livestock use in riparian areas, which are generally used excessively due to the convenience of these areas to livestock. This strategy will be further discussed in Section 2.7 Riparian Areas Grazing.

More often a season-of-use system is used for operational convenience. Examples of seasonal grazing may include repeated spring grazing in a field closer to ranch headquarters to facilitate herd inspection during calving, repeated seasonal grazing of a field due to availability of shelter (trees, shrubs, topographic variation) from winter or early spring storms or making use of fields where water supplies are only available early in the season (Abouguendia and Dill 1993).

2.3 Deferred Grazing

Deferred grazing generally means grazing is delayed on a pasture until specific plant species pass through a critical phenological stage, such as seed set. This system is usually used to protect decreaser species from being grazed at a critical stage of growth and the field is managed for the benefit of these species. Originally, the intended use was to defer grazing for the entire growing season, but shorter deferment periods have also been used (Abouguendia and Dill 1993). Deferred grazing systems can only be applied to operations that have alternate sources of forage

SEASON-OF-USE GRAZING



GRAZING NOTES

A. Range Improvements
Vegetation types were fenced into separate units to give better control over livestock distribution. Seeded pasture is used early in the season to defer the use of native vegetation. Grassland vegetation on the south facing slopes initiates growth earlier in the season and matures earlier than north facing vegetation. Heavier grazing pressure was generally experienced in the south facing field.

B. Management Practices
Cattle graze seeded pasture until the end of June at which time they are moved to the south facing field. Cattle typically graze the north facing field from July until the end of August.

C. Benefits
Vegetation types are used more efficiently by improving overall livestock utilization. Plant vigour is improved with deferred grazing in the south facing field and more carryover is maintained with longer rest periods. Species are used during their best season of use benefiting rangeland and livestock health

This system improves wildlife habitat by avoiding important bird nesting and key mammal reproduction periods.

Deferred grazing in the south facing field can also improve the riparian area along the shoreline of the lake.

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Alberta SUSTAINABLE RESOURCE DEVELOPMENT

Alberta Conservation Association

LEGEND

- Fence line
- Cross fence
- Trail
- Gate
- Salt
- Stockwater
- Dam

FIGURE II-2

SEASON-OF-USE GRAZING IN THE MIXED PRAIRIE

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Figure II-2: Season-of-use Grazing System in the Mixed Prairie

or feed for the deferment period. These may be seeded pastures or other fields more suited to early season use.

Deferred grazing systems may be used to improve plant vigour, reduce the harmful effects of early season grazing, accumulate litter, and ensure current year's growth is available for grazing after the deferment period. For areas that are heavily grazed in the mixedgrass prairie, late season grazing after July is better than early season grazing in terms of good ground cover and litter accumulation (Naeth *et al*. 1991). Early season grazing reduces the heights of standing and fallen litter, decreases live vegetative cover and organic matter mass, and increases bare ground. However, allowing plants to mature often means vegetation is less palatable and less nutritious. Rangelands that are in excellent or poor condition may receive little benefit from implementing a deferred grazing system (Abouguendia and Dill 1993).

Some range grasses may require up to 75% of their winter-stored carbohydrate reserves to initiate the first 10% of growth in the next spring growing season (Wambolt 1979). Grazing plants early in the growing season before there has been adequate leaf growth (2-4 leaf stage) inhibits the carbohydrate buildup in plants. Adverse effects from grazing during this period may also come from instability in the soils during the early season. Mechanical damage may occur to the plant through soil movement, especially on slopes, resulting from livestock impact on the range. However, a plant heavily defoliated in spring before leaf extension is completed and in an environment that is conducive to completing its growth (*i.e*., leaf extension) may very well tolerate defoliation if it is not grazed again (Bogen *et al*. 2003).

The most critical period to the long-term welfare of plants is when the plant has accumulated sufficient leaf area and is directing energy reserves to the seedhead (boot stage) (Wambolt 1979) particularly following a disturbance (Bogen *et al*. 2002). The demand on carbohydrate reserves is high between the time seedheads emerge and flowering ceases. This period also tends to coincide with seasonal lows in precipitation (*i.e.*, mid summer). Because moisture is limiting at this time, plants may be severely stressed to replace foliage and consequently, previous carbohydrate levels.

At the time seed set (ripening) is complete, native grasses normally reach their peak in carbohydrate reserves (Wambolt 1979). Even though the plant appears inactive through the dormant season, carbohydrate levels are somewhat diminished through continued plant respiration. Fall regrowth may also occur if the conditions are favourable, but the impact of defoliation is generally not as great because moisture is not as limiting and carbohydrate reserves are higher on well managed ranges. However, high utilization during fall will reduce energy available to the plant for new growth the following spring.

2.4 Complementary Grazing

Complementary grazing manages seeded pasture and native range to enhance the growth characteristics of both. This system takes into consideration the requirements of the different vegetation types and the needs of the grazing animal. Complementary grazing can accomplish the objectives of deferred grazing by utilizing seeded pasture in the spring and deferring the use of native range. This system is employed to improve the vigour, yield and condition of native prairie, improve overall forage quality, and lengthen the grazing season.

The amount of seeded pasture needed depends on the available forage supply from the native range, the desired length of the grazing season, the selected plant species and its intended season of use, soil zone, and the type and level of agronomic inputs (*e.g.,* fertilization) (Abouguendia and Dill 1993). More recently marginal cultivated lands have been seeded to perennial forage plants. These practices increase the availability of seeded pastures for possible integration with the native range.

In grassland systems, crested wheatgrass provides early, highly nutritious forage at a time when native range is most vulnerable to defoliation (Grazing and Pasture Technology Program 1995). Meadow brome (*Bromus biebersteinii*) may be used similarly in regions where crested wheatgrass invasion into native prairie is a concern or average growing season precipitation is higher. Seeded pasture can often be regrazed in the fall or taken off for hay.

Seeded pasture also requires some form of grazing management to maintain production and long-term viability. Grazing too soon is a major factor leading to pasture deterioration. Seeded species should have approximately 15 cm (6 inches) of growth before grazing is initiated (Alberta Agriculture, Food and Rural Development (AAFRD) 1998). Adequate carryover is also required for seeded species to ensure enough leaf area remains to facilitate new growth and store carbohydrates.

Figure II-3 demonstrates how complementary grazing may be utilized on the fescue prairie for a ranch with a mosaic of native and seeded pasture. Fences constructed based on vegetation types allows for greater control of livestock distribution and better overall utilization of the forage.

2.4.1 Skim Grazing

Skim grazing is not usually considered a grazing system, but is useful to mention as a grazing strategy to be used in conjunction with a particular grazing system. It is similar to complementary grazing in terms of utilizing exotic (nonnative) and native species during their season of best use. It is used to promote livestock use of native rangeland areas encroached by exotic forage. Commencing grazing in mid-May potentially reduces or prevents further expansion of exotic species encroachment by grazing these species when they are most palatable.

When utilizing this strategy, fields should be grazed for a short duration in the spring to avoid the utilization of native species. Rough fescue, if present in the field, may be preferentially grazed by livestock early in the growing season (Moisey *et al.* 2003). The grazing preference for rough fescue over exotic grasses at this time is dependant on the amount of standing residue within the rough fescue plant. Seed production in exotic grasses may be limited by skim grazing prior to inflorescence (heading out) providing adequate levels of standing residue are maintained in rough fescue. This practice will protect actively growing native plants and reduce the potential to detrimentally affect the long-term sustainability of rough fescue grassland.

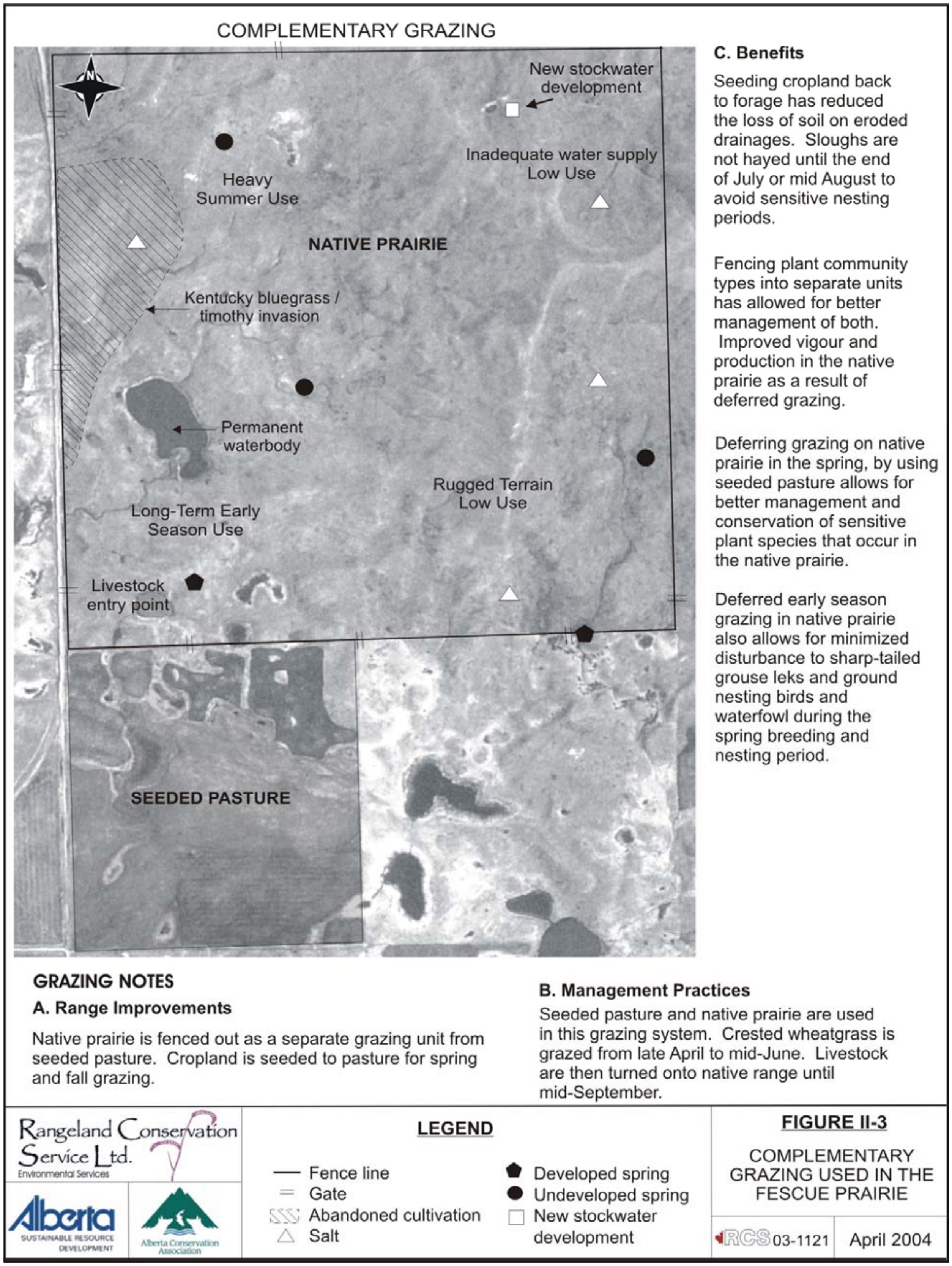


Figure II-3: Complementary Grazing used in the Fescue Prairie

Skim grazing may also be considered in the fall when there is a greater preference for un-senesced (still green) Kentucky bluegrass and particularly fall regrowth than rough fescue (Moisey *et al*. 2003). Fall and fall regrowth grazing may be a practice conducive to the conservation of fescue grassland while taking advantage of the forage production of actively growing invasive species.

2.5 Rotational Grazing Systems

Rotational grazing is designed to reduce selective grazing and overgrazing by concentrating more livestock on a smaller area and forcing overall better utilization (Grazing and Pasture Technology Program 1995). There are many variations of rotational grazing including Switchback, Deferred-Rotation, Rest-Rotation and several intensive rotational systems.

2.5.1 Switchback Grazing

This system applies the same principles as the deferred grazing system, but each of the two pastures receives deferred grazing every other year. A switchback grazing system is the simplest form of a deferred-rotation grazing system. Vegetation response under this system has been slightly to moderately better than continuous or season-long grazing on most ranges (Holechek *et al.* 1995). Deferred-rotation grazing provides a better opportunity for preferred plants and areas to gain and maintain vigour than does continuous grazing (Abouguendia and Dill 1993). It works best where considerable differences exist between palatability of plants. For example, fields with riparian zones often receive excessive pressure in the riparian areas while the surrounding uplands receive little or no use. A deferred-rotation system allows species on the lowland and sacrifice areas the opportunity to store carbohydrates and set seed every other year.

Deferred-rotation systems are often associated with lower livestock gains due to less selectivity, but in terms of economics, the increased stocking rate possible under this system generally compensates for lower animal performance (Holechek *et al*. 1995).

2.5.2 Deferred-Rotation Grazing

This system is similar to switchback grazing, except that delayed spring grazing is rotated among three or more fields. This system delays grazing on a specific grazing area or pasture until desirable plant species have passed a critical growth cycle. This type of a system can provide management flexibility, extra grazing days, optimum stocking rates and a productive rangeland for other resources. Frequency of deferment will depend on the number of fields available to be rotated.

A deferred-rotational system based on phenological stages of key range plants would likely involve three fields. In the first year one of the fields would be deferred until early growth is completed or until the initiation of flowering, reducing the impact of grazing newly initiated growth and to allow for seedling establishment. In the second year, the field would be deferred until seed set is complete to allow seed production and carbohydrate storage. In the third year, the field is grazed first in the rotation. A field grazed first in one year (early) would be grazed last during the next year (late) and grazed second (mid) in the subsequent year.

A deferred switch-back grazing system also allows each field to be grazed at a different stage in the growth cycle of vegetation. This reduces the pressure on plants being grazed repeatedly at a particular time of year when they are most palatable.

The main objective of this system is to improve the vigour of select forage species, usually the decreaser and/or most productive plants. The use of plant groups that initiate growth or are more palatable at different times of the year may be manipulated with this system. To detect changes in species composition when switching from a continuous to a deferred-rotation grazing system requires several years. Smoliak (1960) did not find any changes in the main forage species in the mixedgrass prairie after 8 years of implementing a deferred-rotational grazing system, but did observe a decrease in moss phlox (*Phlox hoodii*) and an increase in little clubmoss (*Seleginella densa*).

Shorter duration grazing also allows plants a longer period to recover following defoliation and reduces the chance of regrowth being grazed in the same season. “Once-over” grazing of native prairie is important in maintaining the health of native grasses as defoliation during the growing stage, especially of regrowth, greatly diminishes the production and vigour of these grasses. “Twice-over” grazing (2 rotations through the grazed fields) may be required in years of low vegetative production due to environmental conditions such as drought.

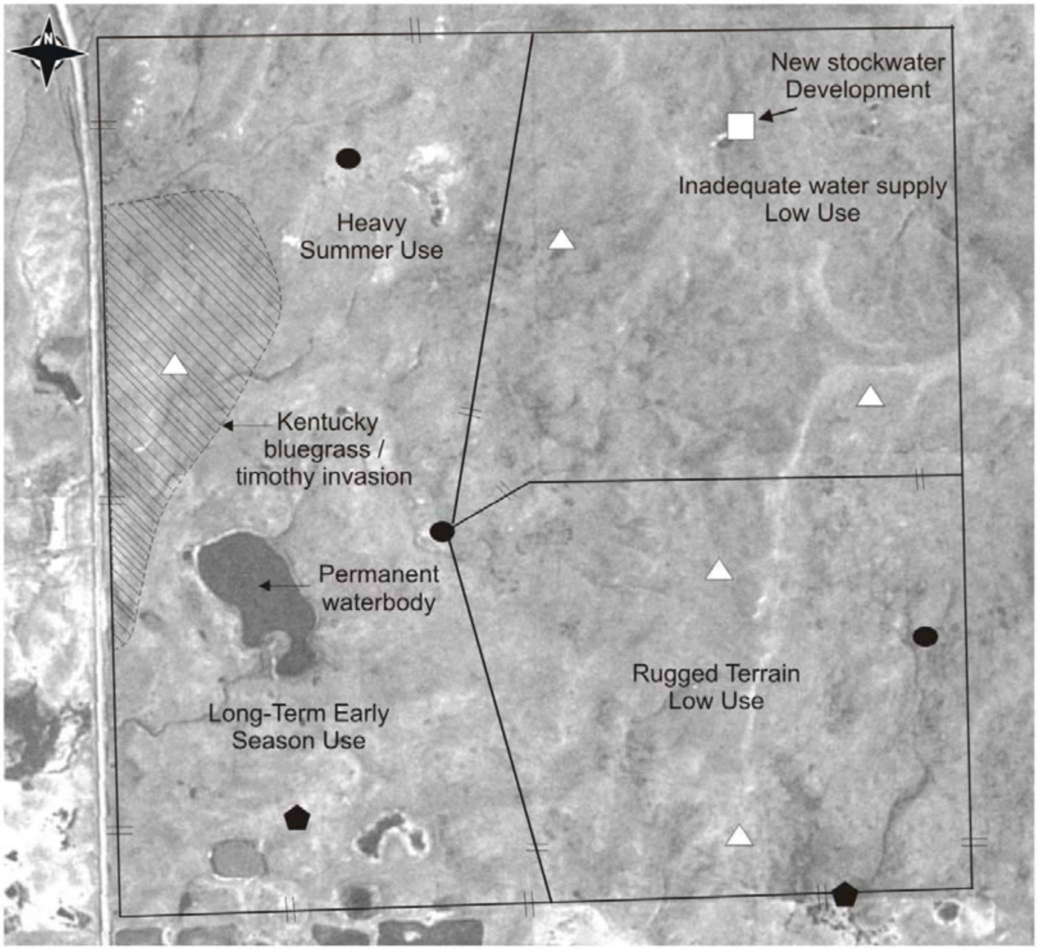
This system is more management intensive than continuous grazing, requiring additional fences and water development. More time is also required to monitor and move livestock. Table II-1 provides an example of how a deferred-rotational grazing system may be implemented with three fields and growth stage of the key forage species being managed for (Figure II-4).

Table II-1 Deferred-Rotational Grazing System

Field	**Year 1**	**Year 2**	**Year 3**
A	Graze 1st*	Graze 3rd	Graze 2nd
B	Graze 2nd**	Graze 1st	Graze 3rd
C	Graze 3rd***	Graze 2nd	Graze 1st

*Active growth
**Flowering
***Seed set

DEFERRED-ROTATION GRAZING



GRAZING NOTES

A. Range Improvements
Water supply was limited in the northwest and livestock had to travel nearly a mile to in some areas to access the supply. Cross fencing, stockwater development and strategic salt placement were used to improve grazing distribution.

B. Management Practices
Deferred-rotation grazing was implemented to reduce the amount of early season grazing and to allow for longer rest periods. Livestock are moved from field to field on the basis of plant growth and carryover rather than by the number of days they occupied a field.

C. Benefits
Improved livestock distribution and rest periods from grazing reduced overall grazing pressure in the fields. Health and vigour of native grasses was improved. An upward trend in range condition was evident. Higher amounts of carryover remaining following the grazing period.

Flexibility in the grazing system provides better control over the season of use in each field. Areas, such as abandoned cultivation, may be grazed occasionally in spring to limit the invasion of exotic grasses into the native prairie.

Sensitive areas for wildlife are more easily managed for and improves the habitat for a variety of wildlife species.

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Alberta Conservation Association

LEGEND

- Fence line
- Gate
- Abandoned cultivation
- Salt
- Developed spring
- Undeveloped spring
- New stockwater development

FIGURE II-4

DEFERRED-ROTATION GRAZING USED IN THE FESCUE PRAIRIE

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Figure II-4: Deferred-Rotation Grazing used in the Fescue Prairie

2.5.3 Merill Rotational Grazing System

Deferred grazing may be used for multipasture, multiherd systems where the length of the grazing period is often longer than the length of the deferment period. An example of a deferred grazing strategy using multiple herds is the Merrill System. This system grazes three herds of livestock in four grazing units with one unit being deferred at all times. In this way the same grazing unit is not grazed at the same time each year. This type of system will repeat itself every 4 years. The Merrill System may be useful for operations that use specific herds for their breeding program. It also works well where common use of the range by more than one grazing animal is practiced. Table II-2 provides an example of the Merrill grazing system.

Table II-2 Three Herd-Four Field Merrill Grazing System*

Season	Field A	Field B	Field C	Field D
Year 1				
Early	Ungrazed	Herd 1	Herd 2	Herd 3
Mid	Herd 1	Ungrazed	Herd 2	Herd 3
Late	Herd 1	Herd 2	Ungrazed	Herd 3
Year 2				
Early	Herd 1	Herd 2	Herd 3	Ungrazed
Mid	Ungrazed	Herd 2	Herd 3	Herd 1
Late	Herd 1	Ungrazed	Herd 3	Herd 2
Year 3				
Early	Herd 1	Herd 3	Ungrazed	Herd 2
Mid	Herd 1	Herd 3	Herd 2	Ungrazed
Late	Ungrazed	Herd 3	Herd 2	Herd 1
Year 4				
Early	Herd 3	Ungrazed	Herd 1	Herd 2
Mid	Herd 3	Herd 1	Ungrazed	Herd 2
Late	Herd 3	Herd 1	Herd 2	Ungrazed

*Adapted from Holechek *et al.* 1989

2.5.4 Rest-Rotation Grazing

In rest-rotation grazing one field is rested from grazing for the entire year. This system requires a minimum of four grazing units to be implemented. In a four-field system, for example, one field would receive early grazing one year, mid-season grazing one year, late grazing one year and a year of complete rest. Although livestock density is increased with rest-rotation grazing, moderate stocking rates are recommended with a proper use factor appropriate for the grassland type.

Rest-rotation grazing is strongly based on improving overall forage quality and minimizing livestock selectivity. It is often implemented to improve plant vigour, improve grazing distribution and overall utilization by increasing animal density. Year-to-year fluctuations in forage production can be planned for due to stockpiled forage in the rested field (Grazing and Pasture Technology Program 1995, Abouguendia and Dill 1993). Rest-rotation grazing is generally superior to season-long grazing in areas where livestock distribution problems occur (Holechek *et al.* 1989). Under proper utilization rates rest-rotation will improve range condition and promote even use of fields in many grassland systems (Johnson 1965, Laycock and Conrad 1981, Holechek *et al.* 1987).

Rotational grazing strategies in the northern Great Plains have had little effect on botanical composition in the short-term (<10 years) (Pitts and Bryant 1987, Hart *et al.* 1988, Taylor 1989, Hart *et al.* 1993). In the mixedgrass prairie, short-term rest (<5 years) from grazing generally does not change the total cover or total herbage yield compared to moderate season-long grazing, but there tend to be changes for individual plants (Vogel and Van Dyne 1966). Vogel and Van Dyne (1966) demonstrated that moderate grazing in mixedgrass prairie increases the relative yield of grasses and sedges compared to forbs and shrubby plants. Although the yield of June grass on grazed areas was shown to be lower than areas protected for four years from grazing, there was twice the number of plants. Protected plants were taller and had larger basal areas. Grasses protected from grazing for a long period of time (>40 years) tend to have greater vigour with needle-and-thread (*Stipa comata*) dominating ungrazed sites and blue grama dominating heavily grazed sites (Dormaar *et al.* 1977, Smoliak *et al.* 1972).

Rotational systems used in areas with livestock distribution challenges due to topography have been effective in improving plant community characteristics (Johnson 1965, Holochek *et al.* 1995). Johnson (1965) used rest-rotational grazing to reduce overall utilization by improving livestock distribution. Increases in total herbage production found in this study were attributed to increased plant vigour as a result of deferment from grazing in the spring or a year of complete rest. This study also found that range improvement is more rapid with rest-rotational systems than a simple rotational system.

One of the most consistently responsive vegetative characteristics to rest-rotation grazing is increases in litter cover for the field that is rested. Naeth *et al.* (1991) found that the height of litter is greater in ungrazed areas of the mixedgrass prairie, but there is no difference in the mass of standing or coarse litter for grazed or ungrazed sites. In grazed areas, trampling tends to reduce litter particle size and create better litter-soil contact. In the mixedgrass prairie, litter accumulation is not high enough to significantly reduce herbage productivity (Willms *et al.* 1986). However, removal of litter from mixedgrass prairie in good condition will decrease herbage production (Willms *et al.* 1993).

In the fescue prairie excessive standing dead and surface litter (>11,000 kg/ha) may lower the production potential for the grassland (Sinton 1980 Willms *et al.* 1986). Litter accumulation generally does not negatively impact range condition, but there is a decline in forage nutritional value in the rested field due to the presence of standing dead plant material.

Litter is vital to the production of grasslands. Soil water is mostly recharged by rainfall, but all rainfall does not infiltrate into the soil. Water may run off or be intercepted by dead or live vegetation. The amount of water taken up by the plant and evaporates from the surface is determined by nature and availability of soil-water, and has drastic effects on both short-term and long-term vegetation production (Willms *et al*. 1993). Plant litter intercepts rainfall but also reduces evaporation from the soil surface by buffering the soil from radiation and air movement. On grassland where the biomass of litter is 5,000 kg/ha, the first 1 mm of precipitation could be absorbed by litter and never reach the soil (Willms, Unpublished data). However, the beneficial effects of reducing evaporation and making more water available for the plant outweigh this small loss of water to the soil.

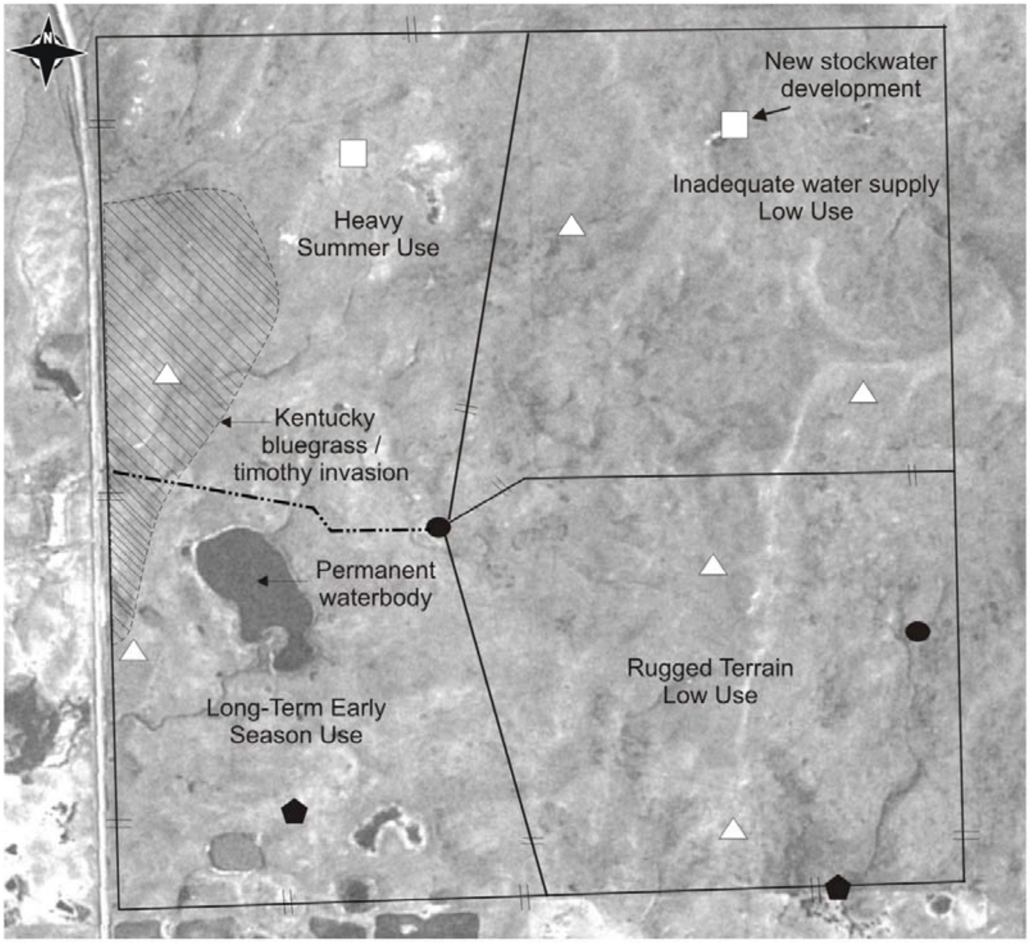
Reductions in livestock numbers may have to be made initially to account for the loss of grazable area with the field that is being rested for the year. However, with improved plant vigour and production, increases in stocking rates may be attainable. Table II-3 provides a description of how a rest-rotational grazing system may be implemented with four fields. The same cycle is repeated starting on year five.

Table II-3 Rest-Rotational Grazing System

Field	**Year 1**	**Year 2**	**Year 3**	**Year 4**
A	Graze 1st	REST	Graze 3rd	Graze 2nd
B	Graze 2nd	Graze 1st	REST	Graze 3rd
C	Graze 3rd	Graze 2nd	Graze 1st	REST
D	REST	Graze 3rd	Graze 2nd	Graze 1st

To implement rest-rotational grazing additional investments may be required. Increased fencing is one of the biggest investments in this grazing system. To reduce high costs associated with permanent fencing, cross fencing may be a single strand, high tensile electric fence. Stockwater may be the major limiting factor in establishing a rotational grazing system. To improve the quality and quantity of drinking water available to livestock surface water supplies should be fenced. Fencing out stockwater may also be an effective way to improve livestock distribution within a grazing unit. Furthermore, keeping livestock out of the water and mud helps prevent disease and protects the water from being contaminated. Reducing sediment load in the stockwater will keep the water temperature lower and reduce evaporation, maintaining higher water levels through the summer. Areas around water troughs should be excavated and filled with gravel, especially in moist areas, to allow spilled water to drain away and reduce the possibility of disease. Figure II-5 provides an example of a rest-rotation grazing system.

REST-ROTATION GRAZING



GRAZING NOTES

A. Range Improvements

Cross fencing was used to create three new fields, but the east side was still heavily used. An electric fence was added to improve livestock distribution. A spring was developed in the northeast.

B. Management Practices

Livestock are rotated through each field based on target utilization rates. One field is rested completely from grazing each year. Salt locations are placed in the area of abandoned cultivation to encourage livestock use and limit encroachment of exotic grasses. A control program has been implemented for areas of noxious weeds.

C. Benefits

Better livestock distribution has led to an improvement in overall range condition. More carryover exists at the end of the growing season due to longer rest periods. Although the system is management intensive it has improved monitoring of noxious weeds and heavily utilized areas.

An improvement in the condition of ephemeral wetlands is evident and an increase in nesting ducks. Increased wildlife use has also been observed.

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SUSTAINABLE RESOURCE DEVELOPMENT

Alberta Conservation Association

LEGEND

- Fence line
- Electric fence
- Gate
- Abandoned cultivation
- Salt
- Developed spring
- Undeveloped spring
- New stockwater development

FIGURE II-5

REST-ROTATION GRAZING USED IN THE FESCUE PRAIRIE

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Figure II-5: Rest-Rotation Grazing used in the Fescue Prairie

2.6 Intensive Grazing

Most intensive grazing systems are based on the Savory grazing method (Savory 1988). They are known as high-intensity-low-frequency (HILF) grazing, short-duration grazing, time-controlled grazing and holistic resource management (HRM). All these systems follow the general concept of very high stocking rates and utilization followed by long periods of rest. High stock densities increase competition for feed between animals, forcing each to spend more time eating and less time wandering. Competition also forces animals to be less selective when grazing. They will eat plant species that would be ignored in other grazing systems. This may result in a reduction of less desirable plant species in the field. The system enables more rigid control of animal distribution with the use of numerous smaller grazing units. This concept was introduced with the objectives of improving the chemical and physical properties of the soil and promoting grassland succession (Savory 1983).

HILF grazing is based on high stocking densities that force the animal to use the available vegetation. Relatively long grazing periods are then followed by long recovery periods. HILF grazing is used most successfully in regions characterized by high rainfall and long growing seasons (Fraser 1993).

Short duration grazing involves relatively high stock densities and short grazing periods. Grazing periods are fixed according to the estimated time needed by key forage species to recover from grazing events. An example or short-duration grazing is provided in Table II-4. The number of days of grazing in a field is determined by the number of fields available to use in the system and the recovery time required for the particular plant community the grazing system is applied in.

Table II-4 Days of Grazing and Recovery Time for Short-Duration Grazing Based on Number of Paddocks*

No. of Paddocks	Days of Grazing	Recovery Time
6	1	5
6	3	15
6	6	30
6	14	70
9	1	8
9	3	24
9	6	48
9	14	112
31	1	30
31	3	90
31	6	180

*Adapted from Fraser 1993.

Time-controlled grazing is similar to short-duration grazing in that stocking densities are high, but this system recognizes that both recovery grazing times vary with the growth rate of key forage species. Grazing periods are short (1-3 days) during rapid growth and longer (7-14 days) during periods of slow growth or dormancy (Abouguendia and Dill 1993). Recovery times vary from 14 to 90 days for this type of system depending on forage growth (Fraser 1993). Time-controlled grazing requires an understanding of the time needed for plant recovery.

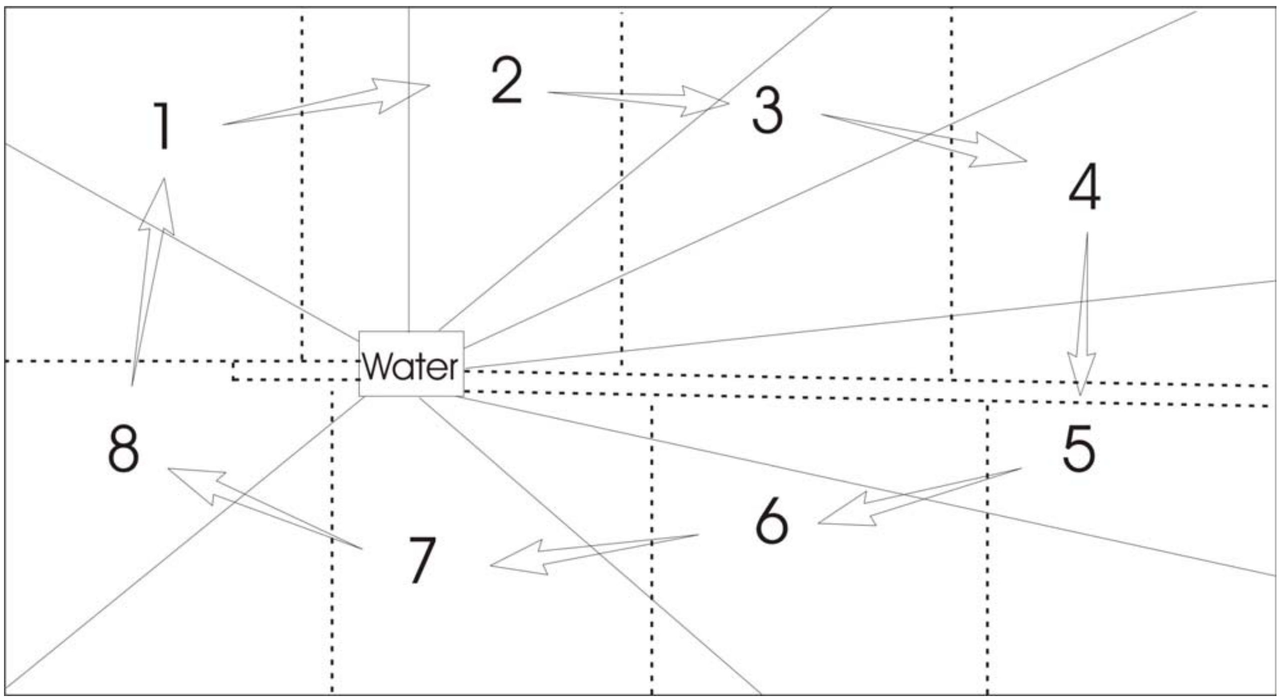
Heavy stocking rates under rotational grazing systems, with repeated high intensity of trampling, reduces infiltration rate and increases erosion (Warren *et al.* 1986, Pluhar *et al.* 1987). In the Northern Great Plains this effect may be temporary since the freezing-thawing effect over winter generally results in a recovery of the hydraulic conductivity (Dormaar *et al.* 1989). Heavy grazing has not been shown to increase bare ground in the mixedgrass prairie in terms of any practical significance (Naeth *et al.* 1991). However, mixedgrass prairie soils tend to be very fragile and have little resistance to ecological change in terms of organic matter (Dormaar *et al.* 1977). Even slight grazing pressure may set off immediate change in the soil organic matter system.

On fescue prairie high stocking rates have been shown to decrease range condition due to the loss of desirable species such as rough fescue (Johnston *et al.* 1971, Dormaar *et al.* 1989). Dormaar *et al.* (1989) demonstrated that short-duration or HILF grazing (approximately 70-80% utilization, 2-3 times the recommended stocking rate and an average grazing period of 4.5 days) resulted in retrogression (return to an earlier seral stage) in fescue prairie. This system also caused less desirable soil conditions by decreasing soil moisture and increasing soil bulk densities indicating reduced infiltration rates. Negative effects of this type of grazing system have also been shown in the mixedgrass prairie (Willms *et al.* 1990). High stocking rates with high levels of utilization tend to result in grassland deterioration despite the short periods (1-3 days) of grazing. High stocking rates on mixedgrass prairie have also resulted in declines in range condition, lower root mass, and lower vegetation densities (Clark *et al.* 1947, Schuster 1964, Willms *et al.* 1990). Continuous grazing appears to create effects similar to HILF grazing, but there is no evidence that these similarities will exist at lower stocking rates (Willms *et al.* 1990).

It may be beneficial to implement an intensive grazing system where control of problem weeds or undesirable species is the management objective. Intensive grazing systems may also be best suited for seeded pastures in more humid climates. Bork (2003) found that control of Canada thistle (*Cirsium arvense*) in seeded pasture was possible through the implementation of a HILF grazing system. High utilization rates (80%) and herd density during each grazing period reduced thistle abundance through grazing (thistle plants are non-poisonous and can be relatively high in forage quality) and trampling.

Intensive grazing systems, such as short duration grazing, generally involve a wagon-wheel arrangement of fences with water and livestock-handling facilities located in the center of the grazing area (Figure II-6). Ideally, using an 8-field grazing system, the rest period would be 7 times as long as the grazing period (*e.g.,* 5 days grazing followed by 35 days rest). Livestock return to pastures only after plants have regrown adequately. Division of grazing units with corridors is considered superior to a star or wagon-wheel shaped arrangement (Grazing and Pasture Technology Program 1995). Grazing tends to be more evenly distributed in the former system with livestock use concentrated in the corridors whereas a star-shaped system will concentrate livestock distribution towards the centre with less use at the ends.

The implementation of intensive grazing systems relies on flexibility and a high degree of management input. Continual monitoring is required to make adjustments to grazing periods, stocking rates and densities and to match the prevailing growing conditions.



--------- Good method of division with corridors
______ Bad method of division (star-shaped)

*Adapted from Grazing and Pasture Technology Program 1995

Figure II-6: Example of an Intensive Grazing System*

2.7 Riparian Area Grazing

There are several options for improving riparian area health through the implementation of livestock grazing systems. These may include controlling the way livestock access riparian areas or implementing grazing systems that provide adequate rest from grazing or exclusion of grazing during critical periods for riparian vegetation. Healthy, functioning riparian areas may provide improved habitat for wildlife and aquatic organisms, more stable channels, improved water quality and a shift toward perennial streamflow (Fitch and Adams 1998).

Livestock access to water can be focused by providing graveled or hardened access points that livestock prefer to use. This minimizes the impact on the entire riparian area and access points are easy to monitor for deleterious effects (*e.g.,* addition of sediment, weeds). Off-stream watering sites may also be used. Cattle demonstrate a high preference for drinking from a water trough and will often walk further to drink from a trough rather than drink from a stream when given free access to both (Veira 2003).

Restricting livestock access to the riparian area may be necessary to benefit the health of the system (Fitch and Adams 1998). By controlling the timing of grazing, vulnerable periods when the stream banks are soft or key species are adversely affected may be avoided. Periods of rest will enhance plant vigour, allow for bank building and allow tree seedlings to grow and reach a more grazing resistant stage. Reducing grazing intensity in riparian areas results in better plant vigour and composition of desirable native species. Grazing systems involving several fields can provide adequate rest and deferment periods at appropriate times to enhance riparian area vegetation. This can increase the control over the grazing in the riparian area through regulating animal numbers, season grazed, length of grazing and rest periods. Riparian areas may be fenced into separate pastures, with separate management objectives and strategies. In high risk or chronic problem areas corridor or exclusion fencing may be the only option for mitigating riparian grazing problems.

Grazing system options must address the needs of key vegetation for maintaining or restoring riparian areas due to the complex and unique character of these ecosystems (Platts 1991). Several types of vegetation are required to establish riparian function. Species with deep, fibrous roots provide sod mats and woody species provide roots and large woody debris. Along with a diversity of multilayered vegetative cover, the presence of these species lends stability to the system. Vegetation cover and residue must be present in adequate amounts to attenuate high flows when they occur. Grazing systems must also provide rest during vulnerable periods when banks are saturated and easily damaged and in autumn when woody species are most vulnerable to browsing.

The effectiveness of using livestock distribution tools to protect riparian areas without fencing is generally dependent on the homogeneity of the landscape. In environments where there is little resistance to the distribution of livestock in the upland (*e.g.,* flat prairie), off site watering systems and salt placement may be sufficient. In other terrain additional measures such as herding, upland vegetation manipulation (fertilization, burning, reseeding) and permanent or temporary fencing may be required (Kinch 1989). Depending on the time of year the riparian area may be used and the type of terrain, shade and/or shelter facilities in the upland may also effectively distribute livestock. The entry point of the livestock herd may also impact the riparian area. Turning cattle into a field away from the riparian area will delay the impact to the system if water is provided off-stream.

Most environments require some form of grazing system to maintain riparian function and health. Season-long grazing can be successful in a homogenous mixedgrass prairie landscape where riparian areas are mostly ephemeral if applied at the proper stocking rates and through effective livestock distribution tools (Fitch and Adams 1998). In more complex range landscapes with well developed riparian areas, season-long grazing will adversely affect riparian vegetation. The tendency for livestock to congregate in riparian areas creates unequal grazing pressure in these areas and will result in overgrazing despite using moderate stocking rates that are based on the entire field.

Recommended utilization rates in riparian areas fall in the range of 25 to 65% to ensure that the necessary amount of vegetation remains to provide adequate cover to protect banks during high runoff periods, to filter or trap sediment and dissipate stream energy (Fitch and Adams 1998). Where overgrazing occurs in the riparian area, plant species with deep, binding root mass are replaced by shallow or tap-rooted species that have poor bank stabilizing characteristics. This results in a widening of the stream channel, and shallower and warmer water. The system is less capable of capturing and holding water though the growing season and riparian vegetation is no longer supported.

2.7.1 Rest-Rotation Grazing

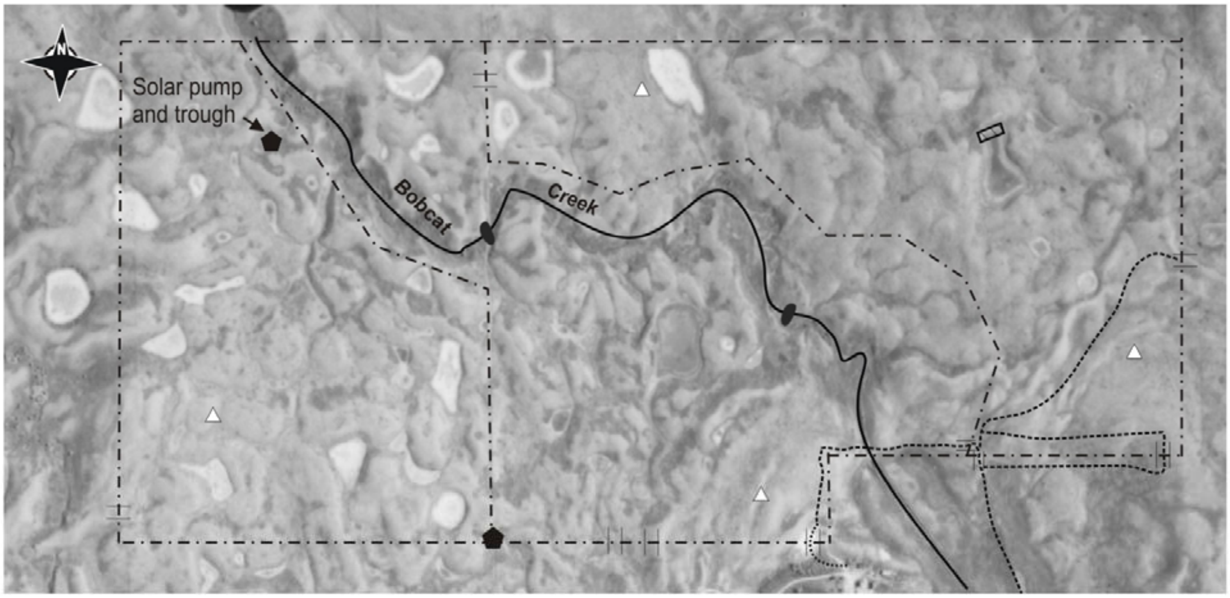
Incorporating a year of rest into the grazing rotation may be necessary for some degraded riparian areas to recover. Sufficient rest will restore fragile stream banks or allow woody species to be maintained. The recovery and maintenance of preferred shrubs, such as willows (*Salix* species), will generally be better facilitated by rest-rotation grazing. Where the goal is to regenerate new trees like cottonwoods, several years of rest may be required (Fitch and Adams 1998). The amount and sequence of rest periods will depend on the species of trees and shrubs that are or have the potential to exist in the riparian area.

Rest-rotation applied in fields with rugged terrain and riparian systems increases utilization 20 to 30% on upland areas compared to deferred-rotation or season-long systems (Holechek *et al.* 1995). Although livestock may still heavily utilize low-lying areas in this type of landscape, the riparian vegetation recovers well when given periodic non-use during the growing season. Figure II-7 provides an example of rest-rotation grazing used for a riparian area in the fescue prairie. Prior to the construction of cross fences the riparian area was heavily favoured by livestock with little use in the adjacent upland areas. The health of the creek was declining, indicated by a loss of riparian vegetation (*e.g.,* sedges, willows) and severe down-cutting of the creek inhibiting the creek from accessing the floodplain during high water events.

2.7.2 Deferred-Rotation Grazing

Using rotational grazing in riparian areas requires that grazing units be divided into fields comprising both upland and riparian areas. Fields may have the riparian area excluded from the uplands and in this instance off-stream water development would be required. Dividing the grazing unit into smaller fields provides better control over livestock movements and encourages more even use of the field. In this way livestock are forced to utilize a greater extent of the upland, to distribute grazing pressure more evenly and reduce livestock selectivity, especially in riparian areas. More effective rest will be achieved by shortening the grazing period, providing a longer rest period and reducing the regrazing of plants to improve their vigour. Although the field is subject to higher stocking density, the field is utilized for a shorter period of time deferring use of the riparian area early in the growing season or providing periods of rest following grazing.

REST-ROTATION GRAZING STRATEGY FOR RIPARIAN AREA MANAGEMENT



GRAZING NOTES

A. Range Improvements

Cross fencing was constructed to make three fields and implement rest-rotation grazing. Created gravelled livestock access points for creek crossings. Developedstockwater along the south fence line and added portable solar pump and trough system.

B. Management Practices

A deferred rest-rotation system was necessary in this field to allow new woody seedlings to establish and provide sufficient rest from grazed to reach a grazing resistant stage.

The upland fields are grazed in a switchback manner each year beginning in May. The riparian field was rested from grazing the first two years and is now grazed at the end of the summer in most years. The amount and sequence of rest periods will vary with the rate of recovery in the riparian area.

Once the riparian area reaches a healthy and stable state and depending on the yearly climatic conditions, it may be possible to graze one upland field, the riparian field and rest the other upland field.

C. Benefits

Improved livestock use of adjacent upland area in riparian fields. Occasional rest from grazing in the riparian field has promoted stream-bank building and the growth of riparian vegetation. Improved stability of riparian area and better vegetation cover has decreased suspended sediment in the water as well as lowered the potential for downstream damage during high water events. The stream has become less intermittent during the growing season

The overall wildlife habitat has improved and fish are found more frequently in the stream.

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Alberta Conservation Association

LEGEND

Fence line	Salt
Trail	Stockwater
Gate	Access point
Dam	Creek

FIGURE II-7

REST-ROTATION GRAZING STRATEGY FOR RIPARIAN AREA MANAGEMENT

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Figure II-7: Rest-rotation Grazing Strategy for Riparian Area Management

Figure II-8A provides an example of two ways to manage riparian areas within the mixedgrass prairie. The first is using deferred-rotation grazing to manage the riparian area. The grazing unit was previously divided into two fields which were grazed in the same sequence every year during the spring and summer. Degradation of the riparian area in the field grazed in the spring every year was evident. An additional cross fence was constructed to divide the field into three units which are grazed in a deferred rotational sequence. Smaller grazing units have provided greater control over livestock distribution and have promoted utilization of the upland areas. Deferring grazing in the riparian area and longer periods of rest from grazing has resulted in a positive trend in riparian health.

2.7.3 Riparian Pasture

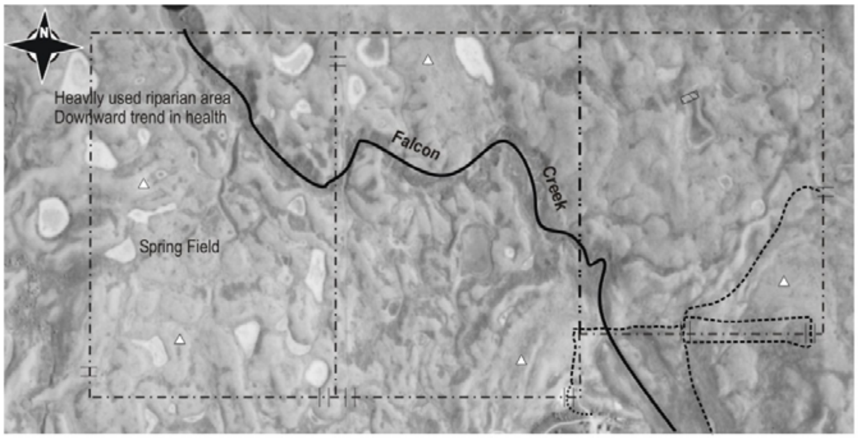
Riparian pastures reflect variation in the landscape and fencing occurs along the boundaries of vegetation units rather than section lines. The riparian area is fenced off from the upland and grazed as a separate unit. Livestock distribution is easier to control when the grazing unit is homogenous. Control over livestock grazing during vulnerable periods allows for optimum recovery or maintenance of riparian health and function. Periods during which riparian areas are most vulnerable to degradation from livestock grazing include spring when stream banks are soft and autumn when riparian vegetation is more palatable than upland vegetation.

Figure II-8B demonstrates how this grazing unit could be managed to maintain or improve riparian health with the use of a riparian pasture. This enables control of livestock grazing in the riparian areas to best meet the needs of riparian vegetation. The optimum period for grazing the riparian pasture would be during the summer after spring runoff and stream banks are no long soft, and before the dormant season. Grazing during the dormant season will progressively set back woody species that are essential for stabilizing stream banks and provide shelter for livestock. Healthy riparian areas tend to remain green for a longer period after upland vegetation has senesced and also retain higher nutrition through the dormant season. Grazing riparian areas during this period results in high livestock preference for the types of vegetation in riparian areas that are vital to maintaining healthy streams and banks.

2.7.4 Corridor Fencing

Generally, complete exclusion of livestock by fencing the area immediately adjoining the stream or river system is considered a measure of last resort. Corridor fencing may be feasible in landscapes where topography and vegetation patterns are complex, where land holdings are small and fragmented, or where stream banks are very fragile or severely degraded (Adams and Fitch 1998). Fencing out livestock from the riparian area may facilitate rapid recovery of degraded riparian areas, but often fails to deal with grazing problems on all of the landscape units in the operation. With the elimination of impact from livestock, riparian areas quickly advance to the climax vegetation for that ecological site. Within many prairie ecosystems lack of grazing in these corridors often leads to a build up of grass that can become a management concern. Other alternatives are available, such as those previously discussed, that are not as costly and when properly applied may be as effective as corridor fencing.

A. DEFERRED-ROTATION GRAZING



C. Benefits

In the spring grazed field, areas of low vegetation cover and damage to stream banks have been recolonized by deep-rooted sedges and woody species. These riparian species have encouraged rapid rebuilding of banks as waterborne sediments have been trapped and held.

Greater vegetation cover has improved wildlife habitat and water quality.

GRAZING NOTES

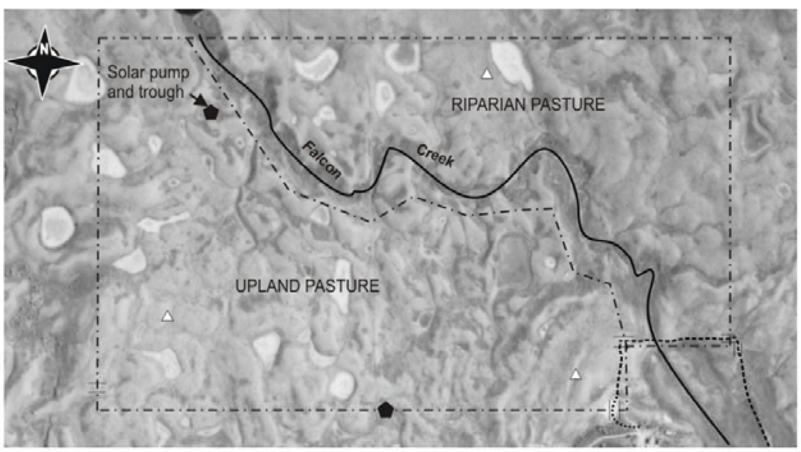
A. Range Improvements

Only the addition of an electric fence was required to implement deferred-rotation grazing for these fields.
The most significant change was in livestock management; moving cattle from field to field as grazing use and the deferral sequence requires.

B. Management Practices

In years of above average forage production, a second, late-season graze also occurs. An additional graze in autumn may be risky if it exposes young woody plants to browsing by cattle and prevents recovery of desirable plants like willow.

B. RIPARIAN PASTURE



B. Management Practices

The field is divided into an upland and riparian pasture to create more homogenous vegetation units. The upland field is grazed early in the season and the riparian pasture is grazed in late summer. In years when alternate forage is available (seeded pasture) the uplands field is deferred from grazing until fall.

C. Benefits

Fencing and deferring use of riparian pastures can be beneficial to vegetation, stream banks and livestock. Cattle are restricted from grazing the riparian area until mid summer by the time which most nesting birds and small mammals have completed critical activities associated with reproduction.

The majority of vegetation growth has been completed so the negative impact on plant vigour is minimized.

GRAZING NOTES

A. Range Improvements

A greater capital investment is required to use a riparian pasture approach for this grazing unit. Fencing and additional stockwater development is needed to create a riparian pasture that can be used as part of the livestock grazing system.

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LEGEND

– · – · –	Fence line	⬟	Stock water
– ·· –	Electric fence	▧	Dam
·········	Trail	△	Salt
=	Gate	∿∿	Creek

FIGURE II-8

DEFERRED-ROTATION AND RIPARIAN PASTURE GRAZING SYSTEMS USED IN THE MIXED PRAIRIE

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Figure II-8: Deferred-rotation and Riparian Pasture Grazing Systems used in the Mixed Prairie

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PART III: BENEFICIAL MANAGEMENT PRACTICES FOR SELECT MANAGEMENT SPECIES IN THE MILK RIVER BASIN

I: BIRDS

A. RAPTOR GROUP

1 INTRODUCTION

The purpose of this report is to summarize and compare the ecology and habitat requirements of five raptor species found within the Milk River Basin: the ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsoni*), golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), and short-eared owl (*Asio flammeus*). Based on this information, the potential effects of grazing and various grazing systems on raptors and their prey are discussed. This discussion is followed by a summary of recommended beneficial management practices to enhance raptor habitat in the Milk River Basin in Alberta. These recommendations can be applied to the range of these species within the Grassland Natural Region of Alberta (Alberta Environmental Protection 1994). Lastly, a brief summary of additional information needs is presented.

As predators, raptors have a vital role to play in the prairie ecosystem. In Alberta, the *Wildlife Act* affords protection to raptors from being killed or harassed by people. However, it is impossible to effectively protect prairie raptors without appropriate management of their prey and habitat (Paton 2002). The majority of the raptors discussed in this report share similar foraging and / or breeding habitat requirements, including a reliance to a lesser or greater degree on native prairie where livestock grazing is the dominant land use. Consideration of the effects of grazing on raptors is therefore highly relevant. It is also important to consider strategies to minimize potential impacts due to other human activities, such as industrial development, which can pose a risk to these species or their habitats.

2 FERRUGINOUS HAWK

2.1 Background

The ferruginous hawk breeds in 17 states in the United States and three prairie provinces in Canada (Schmutz 1999). Approximately 12% of its breeding range is within Canada (Schmutz 1999). In Alberta, ferruginous hawks breed throughout much of the southern portion of the province, with few breeding pairs found north of Consort (Schmutz 1999). High densities of ferruginous hawks and ferruginous hawk nests have been found along the upper portions of the Milk and St. Mary Rivers (Erickson 2000, Quinlan *et al.* 2003). The majority of hawks that breed in Alberta spend the winter in Texas (Schmutz and Fyfe 1987). In general, the winter range of ferruginous hawks extends throughout much of the southwestern United States into Mexico (Schmutz 1999).

Range-wide declines in ferruginous hawk populations are suspected to have occurred over the past few decades (Schmutz 1999). Historic records indicate at least a 40% reduction in the ferruginous hawk breeding distribution in Alberta (Schmutz 1999). Populations in Alberta increased from 1982 to 1987, were similar between 1987 and 1992 and decreased from 1992 to 2000 (Taylor 2003). Due to these declines, the ferruginous hawk is considered "At Risk" in

Alberta and is designated as "Threatened" under Alberta's *Wildlife Act* (Alberta Sustainable Resource Development (SRD) 2001a). Ferruginous hawks are also designated a species of "Special Concern" according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2002). Habitat alteration and fragmentation due to cultivation and intensified industrial land use; human disturbance during nesting; vehicle collisions; and poisoning of primary prey species are all factors contributing to the decline of ferruginous hawks in Alberta and throughout its range (Schmutz 1999).

2.2 Ecology

Ferruginous hawks are usually monogamous and will have one mate for one to several breeding seasons (Schmutz 1999). Hawks will pair up prior to or soon after arriving on the nesting grounds in Alberta in late March to early April (Schmutz 1999). Nest building starts in April and females lay 1 to 5 eggs in April or early May (Schmutz and Hungle 1989). Ferruginous hawks construct nests on the ground or in elevated structures such as trees (see 2.3.3). Male hawks provide food for the young while female hawks are primarily responsible for incubation. In Alberta, hatching occurs in late May to early June and has been correlated with the emergence of young Richardson's ground squirrels (*Spermophilus richardsonii*) (Schmutz *et al.* 1980). Based on a study of 629 nests in North Dakota, Gilmer and Stewart (1983) found that hawk pairs produced an average clutch of 4.1 $\pm$ 1.0 eggs.

Ferruginous hawk juvenile mortality (during the first year) is estimated at 65% (Schmutz and Fyfe 1987), but is thought to decline to approximately 25% among adults (Woffinden and Murphy 1989). Fledglings and adults typically remain near the nest for one month or move short distances to favoured hunting areas within the territory (Schmutz 1999). Ensign (1983) noted that juveniles remained in the vicinity of the nest during the first week after fledging, making flights of up to 200 m. Flight was generally observed to be mastered in the second week. Juvenile hawks will begin their southerly migration in August, while adults have been known to remain in the nesting area as late as mid-October (Bechard and Schmutz 1995).

2.2.1 Diet

Small mammals, typically *Leporidae* (rabbits and hares) and *Sciuridae* (ground squirrels and prairie dogs) make up most of the breeding season diet of the ferruginous hawk. In the mixedgrass prairies of Alberta and North and South Dakota, Richardson's ground squirrels are the primary prey consumed (Lokemoen and Duebbert 1976, Gilmer and Stewart 1983, Schmutz 1987). Ground squirrels can constitute up to 89% of prey items consumed during the nestling period in Alberta (Schmutz *et al.* 1980). Ferruginous hawk pairs have been estimated to consume approximately 400 to 480 ground squirrels per breeding season to maintain the pair and its young (Michener 1997). Schmutz (1989) noted that ferruginous hawk breeding density near Hanna, Alberta compared similarly to the abundance of Richardson's ground squirrels. Gilmer and Stewart (1983) also suggested that nest densities and reproductive success of ferruginous hawks in their North Dakota study area was likely dependent on the abundance of Richardson's ground squirrels. Other important prey species include black-tailed jackrabbits (*Lepus californicus*), white-tailed jackrabbits (*Lepus townsendii*), northern pocket gopher (*Thomomys talpoides*) and meadow voles (*Microtus pennsylvanicus*) (Lokemoen and Duebbert 1976, Ensign

1983, Gilmer and Stewart 1983). Black-tailed jackrabbits comprised between 79% and 89% (by weight) of ferruginous hawk prey items in two years of study in northern Utah and southeastern Idaho (Howard and Wolfe 1976). Birds such as the western meadowlark (*Sturnella neglecta*) and insects typically constitute a minor component of ferruginous hawk diets (Dechant *et al.* 2001a). Olendorff (1993) remarked that ferruginous hawks can switch to other prey when their principal prey species declines, where alternative prey species are available.

In years of low prey availability, ferruginous hawk nest success and clutch size declines significantly (Ensign 1983). Woffinden and Murphy (1989) and Ensign (1983) both report higher nestling mortality in years of low prey numbers.

2.3 Habitat Requirements

2.3.1 General

Ferruginous hawks, birds of the "open country", occur in the Mixedgrass, Dry Mixedgrass, Northern and Foothills Fescue Subregions of Alberta's Grassland Ecoregion and sporadically in the Parkland Ecoregion (Schmutz 1999). Uncultivated grassland forms a major component of ferruginous hawk habitat (Olendorff 1973, Gilmer and Stewart 1983, Konrad and Gilmer 1986, Schmutz 1987). In general, ferruginous hawks breed where grazing is the dominant land use (Schmutz 1999). Sparse riparian forests, periphery forests, terrain features such as cliffs and rock outcrops and isolated trees and small groves add to the suitability of an area for ferruginous hawks (Olendorff 1993).

The habitat suitability index (HSI) model for ferruginous hawks in the Milk River Basin was based on the following assumptions: native prairie provides higher quality habitat due to less disturbance; areas of less disturbance are selected for nesting; breeding areas overlap or are adjacent to foraging areas; and foraging areas are suitable for Richardson's ground squirrel (the main prey) (Taylor 2004). Two variables were included in the final HSI model: native prairie cover and soil texture. Habitats with moderately coarse texture soils were given a higher suitability rating as these soils are required by most burrowing mammals.

2.3.2 Breeding Habitat and Land Use

For all raptors, breeding habitat is comprised of nesting habitat and suitable foraging habitat. In general, suitable ferruginous hawk breeding habitat consists of at least 50% native prairie with solitary or small groups of trees at least 500 m away from disturbance (Schmutz 1982, Dechant *et al.* 2001a).

Ferruginous hawk nesting density has been negatively correlated with the amount of cultivation present (Konrad and Gilmer 1986, Schmutz 1987). As the amount of cultivation increases, foraging opportunities for ferruginous hawks decline while the potential for human disturbance during breeding increases. Ferruginous hawks are particularly easily disturbed during the early stages of nesting (Dechant *et al.* 2001a). In South Dakota, nests further than 2.47 km from occupied buildings had an 11.4% greater probability of fledging young than nests closer to buildings (Blair 1978). In Alberta, Schmutz (1982) noted that the majority of ferruginous hawk nests were located further than 500 m away from active farmyards. In North Dakota, ferruginous hawks avoided nesting in cropland or within 700 m of occupied buildings (Gaines 1985). Lokemoen and Duebbert (1976) found that 11 of 12 ground nests were located further from human activity than randomly selected points in mixedgrass prairie in South Dakota. Ensign (1983) commented that nest locations in southeastern Montana indicated a selection for sites removed from areas of vehicular traffic and /or constant human activity.

2.3.3 Nesting Habitat

Ferruginous hawks take advantage of natural and artificial structures for nesting, where available, provided an adequate forage base is available in the vicinity (Dechant *et al.* 2001a). Cliff ledges and the tops of hoodoos along the upper Milk River provide important nesting habitat for ferruginous hawks within the Milk River Basin (Quinlan *et al.* 2003). Ferruginous hawks will also commonly nest in trees, man-made structures (*i.e.,* nest poles, roofs of abandoned building or artificial platforms) or steep slopes (Schmutz 1987).

Olendorff (1993) analysed data from 2119 ferruginous hawk nests and found that trees or large shrubs (49%) were used most commonly, followed by cliffs (21%), utility structures (12%) and dirt outcrops (10%). Ground nests made up only 6%, haystacks 2%, and buildings 0.1% of the total nests sampled. Ground nesting was likely more prominent prior to European modification of the prairies through fire suppression and shelterbelt planting (Schmutz 1999). In areas where trees are sparse, ground nests are more common (Dechant *et al.* 2001a). For example, Ensign (1983) found that of 91 nests found in rangelands of southeastern Montana, 97% were on the ground. Ground nests are typically located on cutbanks of varying steepness (Schmutz 1982), on hill tops, ridges, or along the upper slopes of southerly to westerly aspects (Lokemoen and Duebbert 1976, Blair 1978, Ensign 1983, Gilmer and Stewart 1983). Lokemoen and Duebbert (1976) speculate that nests are oriented to allow incubating birds to rise easily into prevailing winds. In central North Dakota the majority of ground nests were found on top or next to a large boulder or outcrop (Gilmer and Stewart 1983). Nest sites that offer optimal vantage points are usually selected (Ensign 1983). In southeastern Montana, occupied ground nests were found on slopes between 15 to 30% (Ensign 1983). In northern Montana, ground nests were found in grass dominated, rolling (greater than10% slope) rangeland (Black 1992). Ground nests in South Dakota were always located in prairie in high condition that was unused or lightly grazed (Lokemoen and Duebbert 1976). Ensign (1983) noted that ground nests were in areas with sufficient vegetation to provide adequate cover from predators while at the same time permitting adequate visibility. Ensign (1983) found that nests were selected near shrub cover that offered chicks and incubating birds additional concealment from predators.

Ferruginous hawks typically avoid nesting in dense tree stands (Dechant *et al.* 2001a). Lokemoen and Duebbert (1976) noted that 48% of 27 nests were located in trees, primarily tall cottonwoods, that averaged 10.4 $\pm$ 2.6 m (range 7.3 m to 14.6 m) above the ground. Lone trees or small, open groves were preferred for nest placement and all tree nests were within 1 km of prairie or grasslands (Lokemoen and Duebbert 1976). Similar findings were reported by Gilmer and Stewart (1983). Unlike ground nests in their study, Lokemoen and Duebbert (1976) noted that tree nests were not placed further from human activity than random, and land use surrounding tree nests was not different from randomly selected units.

2.3.4 Foraging Habitat

Richardson's ground squirrels are the primary prey species for ferruginous hawks in Alberta. Schmutz (1989) showed that ferruginous hawk and ground squirrel populations peaked with small amounts of cultivation, but declined as cultivation exceeded 50% (Schmutz 1989). Therefore, productive foraging habitat for ferruginous hawks consists primarily of native prairie that supports high densities of Richardson's ground squirrels. This typically includes prairie with low cover values, moderately coarse textured soils, and slopes of less than 10% (Downey 2003a, Downey 2004a).

2.3.5 Area Requirements

The average ferruginous hawk territory size is approximately 2.6 km^2 to 7.7 km^2 with a diameter of 1.6 km to 4 km (Call 1978). In South Dakota, Lokemoen and Duebbert (1976) found that ferruginous hawk nests were rarely closer than 2.6 $\pm$ 1.0 km. Olendorff (1993) report a mean "nearest neighbour" distance of 3.4 km based on 22 study years of 11 study areas. In Alberta, Schmutz (1977) found that ferruginous hawk nests were rarely closer than 800 m from the next nearest ferruginous hawk nest. However, ferruginous hawks and Swainson's hawks in Alberta have been known to nest within 0.3 km of each other (Schmut *et al*. 1980). This indicates that while ferruginous hawks demonstrate intraspecific competition, they do not exhibit interspecific competition with Swainson's hawks to the same degree. The average home range diameter for ferruginous hawks is 3.2 to 3.4 km (Jasikoff 1982). Foraging distances from the nest site may vary with the availability of prey (Ensign 1983). Howard and Wolfe (1976) report that 8 out of 9 hunting forays along the Utah-Idaho border were within 800 m from the nest site.

3 SWAINSON'S HAWK

3.1 Background

In Canada, Swainson's hawks breed from southern Yukon, through to western British Columbia, central and southern Alberta, Saskatchewan and southwestern Manitoba (Dechant *et al.* 2001b). Their breeding range extends through the western and central United States and into the Mexican states of Sonora and Durango (Dechant *et al.* 2001b). Although this species appears more adaptable to human disturbance than the ferruginous hawk, and while it seems to have adjusted to agricultural landscapes in many parts of its range, its numbers have declined in parts of the western United States and in the western Canadian prairie (England *et al*. 1997). Due to population declines, Swainson's hawks are considered "Sensitive" in Alberta (SRD 2001a). Local population declines have been linked with decreases in its main prey species, Richardson's ground squirrel, and with the use of pesticides in parts of its winter range (England *et al.* 1997). Other limiting factors include habitat degradation due to intensive agriculture or urban development, shooting deaths, and collisions with vehicles (England *et al.* 1997).

3.2 Ecology

Swainson's hawks migrate between breeding areas in North America and wintering grounds in South America (England *et al.* 1997). In Alberta, flocks begin to gather in preparation for their fall migration from breeding grounds by late August and early September (England *et al.* 1997). Southerly migrations begin by mid-September (England *et al.* 1997). Hawks will generally return to Alberta and Saskatchewan between late April and early May. Swainson's hawks return to the breeding grounds after other raptor species (such as red-tailed and ferruginous hawks) that compete for similar nest sites (Andersen 1995). Swainson's hawks are typically monogamous and pair bonds lasting for 10 years have been reported (England *et al.* 1997). In Alberta, Schmutz (1991) reported that Swainson's hawks did not change mates or territories in years following unsuccessful reproduction. Initiation of pair-bonding begins once birds return to breeding grounds. Nest building begins within 7 to 15 days of arrival and typically lasts for approximately 1 week (England *et al.* 1997). Both members of a pair will build or refurbish a nest. Swainson's hawks will reuse nests built in previous seasons (Dechant *et al.* 2001b). Clutches are initiated from late May through to mid-June. Clutch size varies from 1 to 4, but is typically 3 or 4 (England *et al.* 1997). The incubation period lasts for 5 weeks between mid-May and early July (England *et al.* 1997). The female is primarily responsible for incubation, while the male delivers food to the nest. Fledging occurs approximately six weeks after hatching between late July and mid-August. Swainson's hawks are known to renest following an unsuccessful nesting attempt (Olendorff 1973).

3.2.1 Diet

As with ferruginous hawks, the Richardson's ground squirrel is the main prey of Swainson's hawks throughout Alberta and Saskatchewan (Houston and Schmutz 1995). Ground squirrels averaged 69% of the total prey items for Swainson's hawks near to Hanna, Alberta (Schmutz *et al.* 1980). Like ferruginous hawks, declines in Swainson's hawk density and productivity have been correlated with declines in abundance of ground squirrels in southeastern Alberta and southwestern Saskatchewan (Schmutz and Hungle 1989, Houston and Schmutz 1995). Unlike ferruginous hawks, however, Swainson's hawks typically prey primarily on juvenile and not adult ground squirrels and as a result have a broader diet early in the season (Schmutz and Hungle 1989, Dechant *et al.* 2001b). Swainson's hawks rely on other prey, voles in particular, early in the season during the egg formation and egg laying periods when juvenile squirrels are unavailable (Schmutz and Hungle 1989). As some vole species have been found in high numbers in cultivated fields, this may explain why Swainson's hawks, unlike ferruginous hawks, utilize areas with higher amounts of cultivation (Schmutz and Hungle 1989).

Northern pocket gophers, meadow voles, cottontails and juvenile lagomorphs (rabbits and hares) as well as ground nesting birds are among the other common prey consumed by Swainson's hawks across its breeding range (Gilmer and Stewart 1984, Andersen 1995, England *et al.* 1997, Gerstell and Bednarz 1999). Swainson's hawks are also known to forage opportunistically on grasshoppers (Johnson *et al.* 1987).

3.3 Habitat Requirements

3.3.1 General

Swainson's hawks typically occupy open grasslands with scattered trees or clumps of trees and shrubs (Dechant *et al.* 2001b). Swainson's hawks are fairly flexible in their habitat use and use native shortgrass, mixedgrass, fescue, tallgrass, and sandhill prairies as well as pastures, hayland,

and cropland (Dechant *et al.* 2001b). Within grassland habitats, Swainson's hawks will make use of riparian areas, isolated trees, and shelterbelts (Dechant *et al.* 2001b). Swainson's hawks are also found in the aspen parklands of the Canadian prairies (Dechant *et al.* 2001b).

3.3.2 Breeding Habitat and Land Use

In comparison to ferruginous hawks, Swainson's hawks breed in areas with a greater percentage of cultivation and are apparently more tolerant of human activity. An interspersion of cultivated land with native grasslands appears to have allowed Swainson's hawks to take advantage of easier prey accessibility in harvested fields (Bechard 1982). Other human changes to the landscape such as planted shelterbelts or trees around abandoned farmsteads also appear to have provided Swainson's hawks with greater nesting opportunities than previously available (Olendorff 1973, Gilmer and Stewart 1984, Groskorth 1995).

Schmutz (1984) examined habitat use in 41 km^2 plots in southeastern Alberta in which cattle grazing or cultivation of cereal crops was the dominant land use. Unlike ferruginous hawks, Swainson's hawk nest density was shown to be higher on areas with 11 to 30 % cultivation than on areas with less cultivation. Schumtz (1984) also found that Swainson's hawks nested in closer proximity to human habitation than ferruginous hawks. In comparison, in south-central North Dakota, Gilmer and Stewart (1984) report that mixedgrass pasture and hayland were the dominant (75 %) land uses within both 100 m and 1.0 km of a sample of 27 nests. Gilmer and Stewart (1984) noted that within their study area some pairs were found to nest successfully in sites with intensive agriculture and human activity. In an area with little remnant natural grassland, the Regina Plain Saskatchewan, Groskorth (1995) found that Swainson's hawks selected nest sites with more surrounding grassland, trees, and shrubs and significantly fewer wheat fields within 1 km of the nest site than random sites. Smallwood (1995) reported that Swainson's hawks in the Sacramento Valley, California "preferred" riparian habitat, grassland, alfalfa stands more than 2 years old during irrigation and mowing, and annual field crops during harvest. Hawks "avoided" tilled fields, irrigated pasture, annual field crops, and developed areas.

3.3.3 Nesting Habitat

Swainson's hawks most often nest in trees and shrubs that occur in isolation, are clumped, or form part of shelterbelts (Dechant *et al.* 2001b). Trees used for nesting range in height from 2 m to 22 m (Dechant *et al.* 2001b). Swainson's hawks will use artificial nest platforms and occasionally nest on man-made structures such as telephone poles, however not as commonly as ferruginous hawks (Gilmer and Stewart 1984, England *et al.* 1997, Dechant *et al.* 2001b). Swainson's hawks have been reported to nest on the ground in areas where no suitable trees or structures are available (Dechant *et al.* 2001b).

In North Dakota, Gilmer and Stewart (1984) reported that the most common nesting sites (43%) were located in shelterbelts and that cottonwoods (*Populus deltoides*) were the most commonly used (43%) trees for nesting. In total, nests in shelterbelts and in trees adjacent to wetlands accounted for approximately 65% of all nest sites. Gilmer and Stewart (1984) also noted that approximately 75% of all nests sites were directly or indirectly produced by humans.

3.3.4 Foraging Habitat

Swainson's hawks use native prairie, cropland, and haylands for foraging (Dechant *et al.* 2001b). Use of these habitats varies through the season in relation to ease of prey detection and availability of juvenile ground squirrels. Recently harvested cropland and mowed hayland provide favoured foraging habitat at the beginning and end of the season when hunting success in these areas is improved due to ease of prey detection (Bechard 1982, Schmutz 1987).

3.3.5 Area Requirements

Estimates of Swainson's hawk home range size varies from 6.2 km^2 to 27.3 km^2 (Dechant *et al.* 2001b). In Alberta, Schmutz (1977) reported a minimum radius of 0.35 km for nesting territories. This calculation was based on the assumption that nesting territories were circular and nest sites were in the center of the territory. In Colorado, the reported home ranges for male hawks (31.7 km^2) were greater than those recorded for females (19.9 km^2) (Andersen 1995).

4 GOLDEN EAGLE

4.1 Background

The golden eagle is the largest of the raptors considered in this report. It has a wingspan of up to 2.2 m and can weigh as much as 6.1 kg (Kochert *et al.* 2002). Historically, golden eagles inhabited much of North America (Bechard and McGrady 2002). Today this species has essentially been eliminated from most eastern states, however, nesting populations in Alaska, Canada, and the majority of the western United States are considered to be stable (Bechard and McGrady 2002, Kochert and Steenhof 2002). In Alberta, golden eagles are considered a "Sensitive" species (SRD 2001a). There are an estimated 100 to 250 breeding pairs of golden eagles in Alberta (SRD 2001a). Golden eagles breed mainly along the lower reaches of the major river systems in southern Alberta and in the Rocky Mountain region of the province (Semenchuk 1992). Golden eagles are uncommon in northern Alberta (Semenchuk 1992).

Declines in some nesting populations of eagles in the intermountain western U.S., such as in Utah and in the Snake River region of Idaho, have been directly associated with loss of sagebrush steppe and diminishing jackrabbit populations (Gindrod 2001, Kochert and Steenhof 2002). In general, habitat destruction due to urbanization, industrial and intensive agricultural development in addition to several other forms of direct and indirect human disturbance are the primary factors responsible for declines in this species. Kochert and Steenhof (2002) found that 73% of eagle deaths from the early 1960's to the mid 1990's were human related, including: accidental trauma (27%), electrocution (25%), shooting (15%), and poisoning (6%). Accidental trauma encompasses deaths due to collisions with vehicles, fences, wires and wind turbines. Turbine blade strikes are attributable to the deaths of between 28 to 43 eagles each year in the Altamont Pass Wind Resource Area in west-central California (Kochert and Steenhof 2002). Harness (1997) reported 272 eagle electrocutions in the western U.S. and Canada between 1986 to 1996. Electrocution is a greater threat to juvenile eagles (Snow 1973). Lead is the most common cause of poisoning deaths of golden eagles (Wayland and Bollinger 1999). Lead shot or bullets may be one of the main sources of lead poisoning (Wayland and Bollinger 1999, Kochert and Steenhof 2002). Agricultural pesticides, primarily organophosphates and carbamates, account for the majority of remaining poisoning deaths. These pesticides are often ingested through consumption of other animals poisoned with these chemicals. Another form of human induced mortality is nest abandonment due to direct human disturbance of nests during incubation (Boeker and Ray 1971, Snow 1973).

4.2 Ecology

Eagles return to breeding areas from late March to mid-May (Kochert *et al.* 2002). Golden eagles appear to demonstrate fidelity to breeding territories regardless of nesting success (Snow 1973). Nest defense by golden eagles is variable (Snow 1973). Tolerance toward immature eagles has been shown, however, adult eagles are not typically tolerated in nesting areas. Clutch size usually ranges from 1 to 3 eggs (Snow 1973). The female eagle does most of the incubating, however, males will assist with incubation on occasion (Snow 1973). Incubation is thought to be the most critical period during which eagles will desert the nest (Snow 1973). The chance of nest desertion decreases after the young have hatched. The incubation period ranges from 35 to 43 days (Snow 1973). Reported hatching success rates for golden eagles in Montana, Colorado, and Idaho, range from 1.13 young per nest to 2.1 young per nest (Snow 1973). For the first few weeks after hatching, at least one parent is present at the nest, typically the female (Snow 1973). Fratricide is fairly common among golden eagle chicks during the first three weeks due to the size difference of eaglets that are hatched 2 to 4 days apart (Snow 1973). Chicks will fledge at 9 to 10 weeks, however, they will remain dependent on their parents until they are at least 100 days old (Snow 1973). Golden eagles leave northern areas from September to early October to begin their southerly migration for the winter (Kochert *et al.* 2002).

4.2.1 Diet

In general, golden eagles show a strong preference for small mammal prey, particularly rabbits and rodents (Snow 1973). Jackrabbits and cottontails are commonly reported as the main prey item for golden eagles (McGahan 1968, Boeker and Ray 1971, Snow 1973, Marzluff *et al.* 1997a). In Montana, for example, McGahan (1968) found that whitetail jackrabbits (*Lepus townsendi*), desert cottontails (*Sylvilagus auduboni*), and mountain cottontails (*Sylvilagus nuttalli*) comprised 69.8% of the total prey taken by eagles. Similarly, Boeker and Ray (1971) found that jackrabbits and cottontail rabbits provided more than 75% of the golden eagles total diet. Bates and Moretti (1994) found that the number of young produced by golden eagles from 1982 to 1992 in eastern Utah was correlated with rabbit abundance. Although alternative smaller prey such as Richardson's ground squirrels and grouse are more commonly taken, the golden eagle is a powerful hunter and predation on livestock has occasionally been reported (Dekker 1985, Phillips *et al.* 1996). Golden eagles have also been known to prey on young lamb and goat as well as killing larger prey such as adult mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra Americana*), coyotes (*Canis latrans*), domestic calves, and sheep (Woodgerd 1952, McGahan 1968, Phillips *et al.* 1996). A case of severe golden eagle predation of domestic calves was reported in Socorro County in central New Mexico (Phillips *et al.* 1996). In this case, 6 calves were confirmed to have been killed and 48 injured by golden eagles from 1987 to 1989 (Phillips *et al.* 1996). However, typically the impact of golden eagles on ungulate populations is negligible (Snow 1973). Golden eagles will also feed on carrion, making them susceptible to pesticide or lead poisoning (Snow 1973). Brown and Watson (1964) suggest that food supply does not affect golden eagle density as eagles maintain a sufficiently large home range so that a critical food level is rarely reached.

4.3 Habitat Requirements

4.3.1 General

Golden eagles occur in open country, shrublands and grasslands and prefer elevated nest sites, usually cliff ledges, near hunting areas (Grindrod 2001). In Alberta, golden eagles nest on cliffs along prairie rivers or on rocky ledges in the Rocky Mountain region (Semenchuk 1992). Golden eagles occupy definite breeding territories that include feeding, roosting, nesting, and "soaring-playing" areas (Snow 1973). Territory size is dependent to some extent on the availability of food, nest sites, and suitable terrain for flying (Snow 1973).

4.3.2 Breeding Habitat and Land Use

Marzluff *et al.* (1997a) measured spatial use and habitat selection of radio-tagged golden eagles at 8 to 9 territories from 1992 to 1994 in the Snake River Birds of Prey National Conservation Area in Southwestern Idaho. Most eagle home ranges contained more big sagebrush (*Artemisia tridentata*) or rabbitbrush (*Chrysothamnus viscidiflorus*), more cliff or rock outcrop, and less grassland and agriculture than expected based on availability. Within their home range, eagles concentrated their activity within smaller core areas. Avoidance of agricultural lands was significant within 90% of core areas and was consistent among individuals during the breeding and non-breeding season.

4.3.3 Nesting Habitat

The large stick nests constructed by golden eagles are usually located on cliff ledges or shelves or rocky bluffs (Snow 1973, Semenchuk 1992). Golden eagles will also nest in trees and occasionally on the ground. Boeker and Ray (1971) conducted a golden eagle nesting study along the Front Range of the Rocky Mountains in New Mexico, Colorado, and Wyoming. They found that 93% of the 150 nests located during this study were on cliffs and the remainder were in trees or on earthen mounds. Cliffs overlooking open grasslands were more heavily used than those overlooking closed forests. Similarly, in Montana, McGahan (1968) found that 62% of nests located were on cliffs. Douglas fir trees with large enough limbs to support heavy, bulky nests provided the next most common nest site (McGahan 1968).

Height of golden eagle tree nests can vary from 3 m to 30 m above the ground (Snow 1973). Golden eagles will often have at least 2 to 3 alternate nest sites (Snow 1973). Pairs may use the same nest during consecutive nesting seasons, however, they often repair and use alternate nests (Snow 1973). Aspect may play a role in nest site selection. McGahan (1968) proposed that south and east facing sites are superior as maximum sun exposure is especially important during the early spring incubation period when temperatures can drop below freezing. South and east facing sites receive morning sun, with easterly exposures having the added advantage of afternoon shade.

4.3.4 Foraging Habitat

Golden eagles typically forage in open habitats including grasslands or steppe-like vegetation (Kochert *et al.* 2002). Marzluff *et al.* (1997a) reported that golden eagles in southwestern Idaho selected shrub habitats during foraging and avoided disturbed areas, grasslands, and agriculture. Shrub habitat had the greatest potential to contain their principal prey, black-tailed jackrabbits. Selection for areas with abundant and large shrub patches as key foraging areas was particularly apparent for eagles in highly fragmented or dispersed shrublands.

4.3.5 Area Requirements

Marzluff *et al.* (1997a) report that golden eagle home ranges in Idaho ranged from 1.9 km^2 to 83.3 km^2 during the breeding season and from 13.7 km^2 to 1,700 km^{2}outside of this season. However, Marzluff *et al.* (1997a) noted that activity was concentrated in small core areas of 0.3 km^2 to 15.35 km^2 and 4.85 km^2 to 63.8 km^2 during the breeding and non-breeding seasons, respectively. Dixon (1937) mapped the territories of 27 pairs of golden eagles in California, which ranged from 49.2 km^2 to 152.8 km^2, with an average of 93.2 km^2. Dixon (1937) found that territories in hilly terrain were smaller than territories established in flat, open country. Reynolds (1969) studied a golden eagle pair in south-central Montana and reported that the pair spent most of their time in a 33.7 km^2 area, but used a total area of 82.9 km^2. McGahan (1968) reported that the distance between neighboring eagles in Montana ranged from 1.6 km to 16.9 km.

5 SHORT-EARED OWL

5.1 Background

The short-eared owl is a wide ranging species that breeds throughout much of the northern half of North America and migrates as far south as Mexico and the West Indies (Clayton 2000, Dechant *et al.* 2001c). In Canada, short-eared owls breed in every province and territory from the southern border to the low Arctic, however, they are absent from the Boreal Forest and other heavily forested areas (Cadman and Page 1994). Short-eared owls are nomadic and respond irruptively to high concentrations of small mammals (Clark 1975, Holt and Leasure 1993, Clayton 2000, Dechant *et al.* 2001c). Short-eared owl population assessments and breeding habitat evaluations in Canada are complicated by the lack of information from remote northern areas and the owl's irruptive population trends (Cadman and Page1994). Around the turn of the century, in Alberta, the short-eared owl was described as "common" along the Milk River and the West Butte (Macoun and Macoun 1909 as cited in Cadman and Page 1994). There are no current, accurate short-eared owl population estimates in Alberta, however, populations of this species are thought to be declining in all prairie provinces (SRD 2001a). Breeding Bird Survey (BBS) data show a long-term, although non-significant, decline of this owl in Alberta (Clayton 2000). Significant declines in short-eared owl abundance are evident from BBS routes across Canada (Clayton 2000). The most severe short-eared owl population declines in North America have occurred in the northeastern United States (Clayton 2000). Concern over population declines and a paucity of information about this species in Alberta has prompted its listing as

"May Be At Risk". Nation-wide declines and habitat loss have also prompted its designation as a species of "Special Concern" by COSEWIC (2002).

The main reason for short-eared owl declines in North America is generally agreed to be the loss and degradation of habitat due to agricultural, industrial, recreational and urban development (Cadman and Page 1994, Clayton 2000, Dechant *et al.* 2001c). Heavy grazing over large areas is also cited as a factor contributing to habitat degradation (Clayton 2000). Its ground nesting habit and nomadism makes this species particularly vulnerable to habitat loss (Holt and Leasure 1993). In general, food abundance is clearly linked with short-eared owl population fluctuations (Holt and Leasure 1993, Clayton 2000, Dechant *et al.* 2001c). Meadow voles are considered the main "predictive resource" in the Canadian prairies (Clayton 2000). Pesticide use may also be a limiting factor to short-eared owls, but is a topic that requires further study (Holt and Leasure 1993, Cadman and Page 1994, Clayton 2000). Other limiting factors due to human activity include shooting; collisions with vehicles, radio antennas or high-tension guy wires; entanglement in barbed wire; and nest destruction by farm machinery (Clark 1975, Cadman and Page 1994).

5.2 Ecology

Owls are solitary or communal during the nonbreeding season, but are generally considered loosely colonial breeders (Holt and Leasure 1993). Short-eared owls exhibit seasonal monogamy (Holt and Leasure 1993). Pair bonding begins in late winter (mid-February) as communal roosts disband (Holt and Leasure 1993). Males perform an elaborate sky dance display for prospective females. Short-eared owl migrants return to Alberta during March and early April, however, these owls are also known to overwinter in Alberta as far north as Edmonton and Grande Prairie (Clayton 2000). These owls usually breed from early April to late August (Dechant *et al.* 2001c). Nesting may begin as early as late March in areas where wintering and breeding grounds overlap (Dechant *et al.* 2001c). Egg laying can begin as early as May 5 (Clayton 2000). Clutch sizes in North America range from 1 to 11, with a reported mean clutch size of 5.6 (Murray 1976). Eggs are usually laid at 1 to 2 day intervals and are incubated for 24 to 29 days (Holt and Leasure 1993, Clayton 2000). In North Dakota, hatching dates ranged from early May to late July, with a mean hatch date of mid-June (Dechant *et al.* 2001c). Incubation and brooding are performed by the female, while males are responsible for providing food. Short-eared owls may renest if the first clutch is destroyed (Dechant *et al.* 2001c). Owl chicks usually leave the nest when they are between 14 to 17 days old and wander up to 200 m away (Holt and Leasure 1993, Clayton 2000). Fledging occurs when owls reach 27 to 35 days of age (Holt and Leasure 1993). The short-eared owl is known for its ability to breed sooner and increase its clutch size in times of prey abundance (Clark 1975, Holt and Leasure 1993, Cadman and Page 1994, Dechant *et* al 2001c). As short-eared owls are ground nesters and use open habitats they are primarily vulnerable to mammalian predation by species such as red foxes (*Vulpes vulpes*) and striped skunks (*Mephitis mephitis*) (Holt and Leasure 1993).

5.2.1 Diet

Small mammals, in particular *Microtus* voles, dominate the short-eared owl's diet throughout its North American range (Holt and Leasure 1993, Clayton 2000). The owl's diet does not vary much by season, sex or age of individuals (Holt and Leasure 1993). A strong correlation between vole abundance and owl abundance has been demonstrated (Holt and Leasure 1993). Meadow voles (*Microtus pennyslvanicus*) were the predominant prey in 7 of 9 studies from Canada and the United States, constituting 78% to 97% of prey items (Holt 1993). Meadow vole populations undergo a characteristic 2 to 5-year cyclic fluctuation in density. The mechanisms responsible for causing vole peaks over large areas and the geographic extent of these population booms are not well understood (Clayton 2000). In other North American studies where meadow voles were absent or low in abundance, important prey species included: deer mice (*Peromyscus maniculatus*); California voles (*Microtus californicus*); Hispid cotton rats (*Sigmodon hispidus*); and least shrews (*Cryptotis parva*) (Clayton 2000).

The fluctuation of short-eared owl population numbers in response to peaks or ebbs in vole population cycles is well documented (Clayton 2000). Clayton (2000) cites an example of this phenomenon in southeastern Alberta where an apparent increase in the occurrence of owls was correlated with an increase in the abundance of voles in the area as determined by small mammal trapping. In Saskatchewan, Poulin *et al.* (1998) documented a similar synchronous increase in the short-eared owl population in response to a dramatic 1 year increase in the vole population. Short-eared owls hunt primarily at night, however diurnal hunting has been reported (Clayton 2000). Hunting is usually done “on the wing”, flying less than 3 m above the ground (Holt and Leasure 1993). Hovering at higher altitudes (up to 30 m) has also been reported, and less frequently, owls have been noted to use perches for hunting (Holt and Leasure 1993).

5.3 Habitat Requirements

5.3.1 General

In general, the short-eared owl occurs in extensive areas of open habitat (Cadman and Page 1994, Clayton 2000, Dechant *et al.* 2001c). Its main breeding requirement is for sufficient prey adjacent to suitable nesting habitat. Short-eared owls breed in open habitats such as native prairie, haylands, small-grain stubble, wet-meadows, marshlands, peat-lands and clear-cuts throughout the non-mountainous regions of Alberta (Clayton 2000, Dechant *et al.* 2001c). The majority of short-eared owl reports are from the Grassland and Aspen Parkland Natural Regions of Alberta (Semenchuk 1992, Clayton 2000). Short-eared owls will generally sleep, nest, and roost on the ground (Holt and Leasure 1993). In winter owls will tree-roost (Holt and Leasure 1993). Long grass is also often used for roosting (Cadman and Page 1994). Limited specific information is available about historical breeding sites and habitat associations of short-eared owls in Alberta (Clayton 2000).

5.3.2 Nesting Habitat

Unlike the majority of North American owls, the short-eared owl generally nests on the ground (Holt and Leasure 1993, Clayton 2000, Dechant *et al.* 2001c). Nests are usually located on dry upland sites, however, wetter lowlands, such as peat bogs and wetlands are used occasionally (Dechant *et al.* 2001c). The species composition and structure (height and density) of the vegetation in which short-eared owl nests are found varies substantially across the owl’s range (Dechant *et al.* 2001c). Not surprisingly, the degree of concealment of nests varies accordingly.

The apparent diversity of preferred nesting habitat may be an indication of the importance of prey availability in the distribution of breeding sites annually (Clayton 2000).

In general, grass cover is preferred for nesting. Based on an assessment of 63 short-eared owl nests in North America, Clark (1975) found that the majority of nests were located in grassland (55%) and grain stubble (24%). Of the remainder of nests, 14% were found in hayland and 6% in shrubs (*i.e.,* snowberry (S*ymphoricarpos occidentalis*)). According to a 50 year banding program in south-central Saskatchewan, Houston (1997) reported that short-eared owl nests were concentrated in open stubble habitats. In Montana, of the vegetation within 15 m of 28 nests, 85% was grasses, 8% was herbs and 7% was a combination of herb and grass. Ninety percent of this vegetation was less than 50 cm tall, 9% was between 0.5 m to 1.0 m tall and 1.0% was greater than 1 m tall (Holt and Leasure 1993). In two intensively managed grassland complexes in southeastern Illinois, short-eared owls preferred to nest in grass heights of 30 cm to 40 cm such as in rotary mowed fields (Herkert *et al.* 1999). In South and North Dakota, the majority of short-eared owls nests were found, well concealed in undisturbed grass-legume vegetation , 30 cm to 60 cm tall (Duebbert and Lokemoen 1977). Nesting in areas dominated by western snowberry and herbaceous vegetation has also been reported in northwestern North Dakota (Murphy 1993 as cited in Dechant *et al.* 2001c).

5.3.3 Foraging Habitat

Short-eared owls forage in open areas that support cyclic small mammal populations, voles in particular (Clayton 2000). Few studies, however, have specifically evaluated foraging habitat use by this species. Short-eared owls in an agricultural landscape in southern Chile were found to concentrate their hunting along roadsides, in ungrazed meadows, and untilled lands (Martinez *et al*. 1998). Several studies have found that the predominant short-eared owl prey, meadow voles, prefer native prairie or undisturbed meadows with greater amounts of vegetative cover and typically avoid cultivated fields and cropland (Marinelli and Neal 1995, Peles and Barrett 1996, Basquill and Bondrup 1999, Lin and Batzli 2001, Getz *et al.* 2001). Additional research is needed to determine meadow vole densities in stubble habitats, such as in south-central Saskatchewan where short-eared owl banding programs have been conducted (Houston 1997).

5.3.4 Area Requirements

Short-eared owls are generally associated with large, open expanses of grassland (Holt and Leasure 1993, Dechant *et al.* 2001c). Herkert *et al.* (1999) suggest that short-eared owls may respond to the total amount of grassland within the landscape rather than the size of individual grassland tracts. Owls may therefore use small blocks of habitat if the blocks are located near to other more extensive areas of grassland. There is a wide range in the size of documented short-eared owl breeding territories (Holt and Leasure 1993). In Manitoba, breeding territories averaged 0.82 km^2 and ranged from 0.23 km^2 to 1.21 km^2 (Clark 1975, Holt and Leasure 1993). Clark (1975) suggested that breeding territory size may be inversely related to vole density, (*i.e.,* breeding territory size increases with decreasing prey (vole) densities and decreases with increasing prey densities).

6 PRAIRIE FALCON

6.1 Background

Prairie falcons breed in suitable cliff habitats along rivers or water bodies in the Grassland, Parkland, and occasionally the Rocky Mountain Natural Region of southern Alberta (Semenchuk 1992, Paton 2002). Their breeding range in Alberta extends as far north as Red Deer, with nesting areas primarily in cliffs and hoodoos found along the Bow, Red Deer, Milk, South Saskatchewan and Oldman Rivers and their tributaries (Paton 2002). High densities of prairie falcons and prairie falcon nests occur in sandstone cliffs and hoodoos along the Milk River from the town of Milk River to Writing-on-Stone Provincial Park and in Police Coulee (Quinlan *et al.* 2003, Downey and Quinlan 2004 *in press*). The minimum estimated population of prairie falcons in Alberta, 202 pairs, represents approximately 81% of the Canadian population and 6% of the continental population (Paton 2002). Prairie falcons occur to a lesser extent in the dry south central interior of British Columbia (8 estimated nesting pairs) and in southwestern Saskatchewan (40 estimated nesting pairs). Prairie falcons are found year-round in the western and central United States, and their wintering range extends into Mexico.

As prairie falcons in Alberta are at the northern limit of their continental range, their populations are subsequently vulnerable to environmental and habitat changes (Paton 2002). Therefore this is a species of long-term concern. The prairie falcon is ranked "Sensitive" in Alberta due to concern over availability of nest sites and a reported reduction in its northern range (SRD 2001a, Paton 2002). In a 1996 COSEWIC report, Kirk and Banasch (1996) reported an overall stable Canadian population of prairie falcons of 250 to 500 pairs, with possible local declines in Alberta. Due to a lack of evidence of overall population declines, COSEWIC listed the prairie falcon as "Not At Risk" in 1996. Recent surveys showed a reduction of successful breeding pairs along stretches of the Bow River near Calgary at the Bassano Dam (Paton 2002). There has also been a reported reduction in the number of breeding pairs in the Milk River Natural Area (Paton 2002). A decreasing number of prairie falcon nests were observed along the Milk River during recent aerial surveys for raptors conducted in 2000, 2002 and 2003 (Erickson 2000, Quinlan *et al.* 2003, Downey and Quinlan 2004 *in press*). Surveys conducted in 2000 were carried out as part of the provincial peregrine falcon survey (Erickson 2000). Surveys were conducted along the Milk and North Milk River valleys from the point where the rivers enter Alberta to approximately 15 km below Writing-on-Stone Provincial Park (Quinlan *et al.* 2003, Downey and Quinlan 2004 *in press*). Ninenteen nests were found in this area in 2000, while 15 nests and 13 nests were found in 2002 and 2003, respectively (Erickson 2000, Quinlan *et al.* 2003, Downey and Quinlan 2004 *in press*). In general, there is a need for improved survey protocols and more consistent monitoring of core populations of prairie falcons in Alberta to provide a reliable index of population and productivity trends (Paton 2002).

Nesting cliffs near to prairie grasslands with an adequate prey base are essential to maintaining prairie falcon populations (Paton 2002). Habitat loss due to agricultural, urban, industrial, and recreational development is the primary limiting factor for this species. Human induced or natural erosion and flooding is also responsible for loss of nesting sites. Organo-chlorine pesticide contamination and direct human disturbance from shooting or nest disturbance in the early stages of the breeding season are other commonly cited limiting factors (Snow 1974, Paton 2002).

6.2 Ecology

In years with mild winters and adequate prey, adult prairie falcons will winter throughout much of their southern Alberta breeding range (Paton 2002). Juveniles, however, typically migrate to the United States and northern Mexico (Paton 2002). Courtship and mate selection occurs on the breeding grounds several weeks prior to egg laying. In Alberta, breeding territory establishment begins in March and egg laying occurs in mid to late April (Paton 2002). Usually 4 to 5 eggs are laid, however, clutch sizes range from 2 to 6 eggs (Paton 2002). The eggs are incubated by the female for a period of 29 to 33 days. Falcons will renest if the first clutch is destroyed early in the incubation. Falcon young typically fledge at 36 to 41 days, and most are fledged by the third or fourth week of June (Paton 2002). The number of fledglings per nesting attempt is highly variable for falcons across their range, varying from 1.2 to 3.9 young per territorial pair (Paton 2002).

6.2.1 Diet

Richardson's ground squirrels are the dominant component of prairie falcon diets in Alberta (Paton 2002). A study along the Bow River reported that ground squirrels accounted for 89% of the biomass fed to prairie falcon young (Hunt 1993). Fluctuations in the number of successful prairie falcon pairs on the Oldman River Reservoir between 1990 and 1997 appeared to correspond with fluctuations in ground squirrel populations in the area (Fyfe 1997). Similar results have been reported in southwestern Idaho, where researchers have found that falcon reproduction is influenced by abundance of Townsend's ground squirrels (*Spermophilus tonsendii*) (Steenhof and Kochert 1988, Marzluff *et al.* 1997b, Steenhof *et al.* 1999). Prairie falcons, across their range, also consume lesser amounts of other small mammals, small to medium-sized bird, reptiles and insects (Paton 2002). Based on research from a section of the Bow River, ground squirrels made up 68% of the falcon's diet; grassland birds such as horned larks (*Eremophila alpestris*), western meadowlarks (*Sturnella neglecta*) and European starlings (*Sturnus vulgaris*) made up 27%; and small mammals made up 5% (Paton 2002). Consumption of alternate prey items has been shown to increase in years of low ground squirrel numbers (McFadzen and Marzluff 1996, Paton 2002). However, studies suggest that in years of lower ground squirrel abundance, falcon productivity was found to be lower (Marzluff *et al.* 1997b, Steenhof *et al.* 1999, Paton 2002). It is not known how many ground squirrels are needed to support a productive population of prairie falcons (Paton 2002).

6.3 Habitat Requirements

6.3.1 General

Prairie falcons occur in southern Alberta primarily in areas along rivers and streams with clay, sandstone or rock cliffs (Paton 2002). Their core breeding range is found at lower elevations in the Grassland Natural Region (Paton 2002). Falcons will use a variety of habitats including grasslands, canyons, cultivated prairie, alpine tundra, foothills, and dry mountain valleys for foraging and / or breeding (Paton 2002). Areas with extensive forests are avoided. Specialized nesting site requirements make prairie falcons one of the least versatile nesters of Alberta's raptors (Paton 2002). The availability of suitable cliffs, banks or escarpments is a critical breeding habitat requirement for this species.

The HSI model for prairie falcons in the Milk River Basin included three variables: slopes greater than 75 degrees; Richardson's ground squirrel habitat suitability per quarter section; and distance to ground squirrel habitat (Downey 2004b). Areas with slopes greater than 35 degrees and with suitable ground squirrel habitat within 15 km of nest sites were given a high suitability rating. Due to the coarse nature of the data, slopes greater than 35 degrees were most representative of steep slopes within the Milk River Basin (Downey 2004b).

6.3.2 Nesting Habitat

Falcons prefer to nest in secure cliffs with an overhang that provides shelter (Paton 2002). Such sites are typically found along rivers. Nests have been found in natural cavities as well as man-made holes or ledges dug into cliffs of varying substrates, and at a range of heights (Runde and Anderson 1986, Paton 2002). Runde and Anderson (1986) pooled nest site data for 418 sites from numerous studies across the prairie falcon breeding range. They found that the average nest height was in the upper two thirds of the cliff at 29.3 m from the bottom of the cliff (sites ranged in height from 2.1 m to 154.4 m from the cliff bottom). Prairie falcons have also been known to use abandoned common raven (*Corvus corax*), golden eagle, and ferruginous hawk nests (Paton 2002). Occasionally, nests located in trees and transmission towers have been reported (MacLaren *et al.* 1984, Roppe *et al.* 1989). Studies have shown that falcons show fidelity to their breeding territories and return to the same territory used the previous year (Paton 2002). Cliff territories can have more than one nest site, with sites used alternately. Nest sites or nesting territories used repeatedly are called "traditional sites" (Paton 2002). In southern Alberta there are six known traditional sites that have been occupied for a minimum of 10 years, with one nest site used for 23 years (Paton 2002).

6.3.3 Foraging Habitat

Prairie falcon foraging habitat corresponds with habitats that can sustain viable populations of their major prey, Richardson's ground squirrels. Availability of a ground squirrel prey base is therefore thought to be a key factor in the distribution of prairie falcon home ranges in southern Alberta (Hunt 1993, Paton 2002). Hunt (1993) found that radio-tagged falcons along the Bow River hunted as far as 20 km from their nests but that falcons mostly used native prairie with ground squirrel habitat that was within 15 km of nest sites. Large areas of cropland are thought to have eliminated areas of ground squirrel habitat along the Bow River (Usher 1993). Usher (1993) reported that nesting populations of prairie falcons along the lower Bow River declined by greater than 10% while agricultural land use within 6 km of the Bow River increased by 25% from 1972 to 1988. Usher (1993) reported that areas of native range contained most of the ground squirrel habitat in their study area.

In general, prairie falcon hunting ranges decrease during years of abundant prey and unlike nest sites, are not vigorously defended (Paton 2002). In southwestern Idaho, Marzluff *et al.* (1997b) reported that prairie falcons that nested near habitat most suitable for Townsend's ground squirrels, the primary prey in the area, ranged over smaller areas and were more successful breeders than falcons that had to range further to locate ground squirrel prey. Marzluff *et al.* (1997b) confirmed the importance of native grassland habitats as key foraging areas, particularly areas with a mosaic of shrubs and grasses. Overall prey abundance was found to be much lower in agricultural lands than in native shrubland in this study. In addition, grassland communities dominated by exotic annuals such as cheatgrass (*Bromus tectorum*) appeared to provide less suitable habitat for ground squirrels during drought conditions than compared to native perennial grass or shrub mosaics (Marzluff *et al.* 1997b, Steenhoff *et al.* 1999). Marzluff *et al.* (1997b) reported that Sandberg's bluegrass (*Poa secunda*) / winterfat (*Ceratoides lanata*) / and big sagebrush (*Artemisia tridentata*) habitats supported the highest abundances of ground squirrels when their populations were low (Marzluff *et al.* 1997b). Shrub cover is thought to be important to providing forage and cover for squirrels particularly during periods of drought (Marzluff *et al.* 1997b). Interspersed open grassland areas are important as they provide a more effective hunting ground for falcons attempting to catch prey (Marzluff *et al.* 1997b).

Another important component of prairie falcon foraging habitat is the availability of perch sites such as snags, fence posts, rock faces, utility poles, and hay bales (Paton 2002). These perch sites are often used as vantage points from which to seek-out or consume prey (Snow 1974).

6.3.4 Area Requirements

Hunt (1993) estimated the average minimum home range size for prairie falcons nesting along the Bow River to be 72 km^2. Home ranges varied from 31 km^2 to 192 km^2 for the 11 radio-tagged birds in this study (Hunt 1993). Hunt (1993) estimated the core foraging areas for 5 of the pairs to be 26 km^2 to 40 km^2, these areas overlapped between adjacent territorial pairs. Marzluff *et al.* (1997b) confirmed that prairie falcons use distinct areas of native grassland within the foraging territory. Native grasslands most likely to contain ground squirrels in this study were 5 km to 20 km from the nest sites (Marzluff *et al.* 1997b). Marzluff *et al.* (1997b) found that home range size increased with declining prey and also was larger in areas with a reduced percent cover of perennial grass. Falcons that ranged greater than 300 km^2 to forage had less reproductive success than falcons that hunted over areas of between 200 km^2 to 280 km^2 (Marzluff *et al.* 1997b).

7 RAPTOR GROUP COMPARATIVE SUMMARY

Table III-1 provides a comparative summary of the five raptor species considered in this report including a list of key management concerns for each species. Management considerations are discussed further in Sections 8, 9 and 10.

Overall, habitat loss or alteration is the key limiting factor for all species due to the importance of native prairie for providing either critical foraging or nesting habitat for these raptors. Of note, grazing is the dominant land use in the majority of the breeding areas used by these raptors in Alberta. As discussed later, grazing may be particularly important for maintaining open habitat for Richardson's ground squirrels, the dominant prey consumed by ferruginous and Swainson's hawks and prairie falcons. Meadow voles, the primary prey consumed by short-eared owls have fluctuating populations and rely on greater vegetation cover than ground squirrels. White-tailed jackrabbits and mountain cottontails, the primary prey consumed by golden eagles, rely to a greater extent on shrubby cover and edge habitat. All of these prey species are most commonly associated with native prairie. Isolated or small clumps of trees provide important nesting habitat for ferruginous and Swainson's hawks. Cliffs and hoodoos within the Milk River Basin also provide nesting sites for ferruginous hawks as well as prairie falcons and golden eagles (Quinlan *et al.* 2003). Short-eared owls are the only strictly ground nesting raptor. While species differ in their relative tolerances to human activity, in general, all raptors are most susceptible to human disturbance near nest sites early in the nesting season. The key management concerns listed in Table III-1 are based on a consideration of important limiting factors, dominant prey, primary foraging and nesting habitat, and area requirements.

Table III-1 Raptor Group Comparison Summary

Species	Key Limiting Factor	Dominant Prey (in southern Alberta)	Foraging Habitat (general)	Nest Site Characteristics	Land Use Preference / Distance from Disturbance	Area Requirements	Key Management Concerns
Ferruginous hawk	▪ **Habitat loss / alteration** ▪ Richardson's ground squirrel abundance ▪ Disturbance during early nesting season	▪ Primary: **Richardson's ground squirrel** ▪ Secondary: white-tailed jackrabbit; meadow vole; northern pocket gopher	▪ Native prairie with Richardson's ground squirrels	▪ Cliffs along rivers near to suitable foraging habitat ▪ Lone or small clumps of trees or large shrubs; utility structures; dirt outcrops ▪ Ground nests more common where alternative tall structures are absent (often on raised areas in lightly grazed pastures)	▪ Requires at least 50% native prairie ▪ Nests typically located a minimum of 500 m from human disturbance	▪ Average territory size: 2.6 km^2 to 7.7 km^2 ▪ Average hunting distance from nests in Alberta: 800 m	▪ Protect native prairie and Richardson's ground squirrel habitat ▪ Protect nest sites from human disturbance and heavy grazing
Swainson's hawk	▪ **Habitat loss / alteration** ▪ Richardson's ground squirrel abundance	▪ Primary: **Richardson's ground squirrel (juveniles)** ▪ Secondary: meadow vole; juvenile white-tailed jackrabbit; mountain cottontail; insects	▪ Native prairie with Richardson's ground squirrels and interspersed smaller blocks of hayland or cropland with vole prey ▪ Cropland and hayland used after mowing or harvest early or late in the season	▪ Trees and shelterbelts often used for nesting; man-made structures used less often ▪ Ground nesting occasionally reported	▪ Higher nesting densities occur in areas with 11-30% cultivation ▪ Tolerant of greater amounts of human disturbance than ferruginous hawks and will nest closer to human activity	▪ Home range size: 6.2 km^2 to 27.3 km^2	▪ Protect native prairie and Richardson's ground squirrel habitat ▪ Protect and manage cottonwood forests and shelterbelts
Golden eagle	▪ **Habitat loss / alteration** ▪ Collisions with vehicles or human structures ▪ Electrocution ▪ Disturbance during early nesting season	▪ Primary: **white-tailed jackrabbit and mountain cottontail** ▪ Secondary: Richardson's ground squirrel	▪ Shrubby, sagebrush or edge habitats with lagomorph prey	▪ Cliffs along rivers, waterbodies or coulees ▪ Mature, sturdy trees also used for nesting less commonly	▪ Avoids cultivated fields for foraging	▪ Uses core areas ranging from 0.3 km^2 to 15.35 km^2 during the breeding season for foraging	▪ Protect lagomorph prey habitat ▪ Protect tree and cliff nest sites ▪ Minimize disturbance at nest sites
Short-eared owl	▪ **Habitat loss / alteration** ▪ Meadow vole abundance ▪ Heavy grazing over large areas	▪ Primary: **Meadow vole** ▪ Secondary: other *Microtus* (vole) species	▪ Various grassland habitats with meadow vole prey	▪ Ground nests usually in native prairie ungrazed or lightly grazed	▪ Uses a variety of native and non-native grassland habitats where vole populations are abundant	▪ Average breeding territory in Manitoba: 0.82 km^2 ▪ Breeding territory size varies with fluctuating vole densities	▪ Protect meadow vole habitats ▪ Minimize disturbance to ground nests and provide adequate nesting cover ▪ Lightly graze or rest pastures with active nests
Prairie falcon	▪ **Habitat loss / alteration** ▪ Richardson's ground squirrel abundance	▪ Primary: **Richardson's ground squirrel** ▪ Secondary: grassland passerines	▪ Native prairie with Richardson's ground squirrels adjacent to nesting areas	▪ Cliffs along rivers and waterbodies near to suitable foraging habitat	▪ Avoids cultivated fields for foraging	▪ Average home range along Bow River site: 72 km^2; most hunted within 15 km of nests	▪ Protect cliff nest sites from disturbance ▪ Protect native prairie and ground squirrel habitat

8 GRAZING AND RAPTORS

As described by Kochert *et al.* (1988) and Kochert (1989), grazing has the potential to influence raptors by affecting 3 factors in particular, including the:
1) quality and availability of nesting substrate;
2) diversity and abundance of prey; and the
3) vulnerability of prey to raptor predation by removal of cover.

These 3 factors ultimately influence the reproductive success and density of raptors (Kochert *et al.* 1988). The ability to quantify these grazing effects is difficult and to date no definitive quantitative studies have been done (Olendorff 1993). A discussion of the effects of grazing on the nesting substrate and prey base of the 5 raptors considered in this report is given below. The influence of various grazing systems on each of these factors is discussed further in Table III-2.

1) Modification of Tree, Cliff, and Ground Nesting Substrates

The availability of suitable, safe nesting sites has obvious implications for the reproductive success of raptors. The potential effects of grazing on ground, tree, and cliff nesters are discussed below.

A) Tree Nests

Tree nesting species include ferruginous and Swainson's hawks and to a lesser extent, golden eagles and prairie falcons. These species all make use of lone or small clumps of trees in upland areas and riparian habitats. Mature cottonwood forests commonly found along streams and rivers in southern Alberta offer particularly important nesting habitat for raptors and numerous other birds. In southwestern Alberta, the plains cottonwood (*Populus deltoides*), balsam poplar (*Populus balsamifera*) and narrowleaf cottonwood (*Populus angustifolia*), and interspecific hybrids provide the foundation of biologically diverse riparian forests (Gom and Rood 1999). In general, excessive trampling and repeated browsing of mature trees or seedlings, stunts growth and limits the survival and regeneration potential of trees. This type of impact reduces the capacity of trees to provide a suitable and stable nesting substrate. Bradley and Smith (1986) contend that heavy browsing and trampling by cattle negatively affects cottonwood regeneration and density along the Milk River. Cottonwood trees are, however, ultimately dependant on sufficient instream flows and flooding events for growth and seed dispersal and germination (Bradley and Smith 1986). Sparse trees in arid landscapes are especially susceptible to heavy use from cattle if alternate shade or rubbing structures are not available. A lone tree or small clump of trees may be killed through repeated rubbing by cattle causing girdling of the trunk.

The timing and intensity of grazing, placement of upland watering and salt locations, and frequency and duration of rest periods will have an effect on how severely cattle impact trees. Appropriate riparian area management is particularly important for limiting impact to trees. Fencing may be required to protect upland nest trees in arid landscapes that are consistently heavily impacted by livestock. This is likely to be more of a concern under continuous (season-long) grazing.

B) Cliff nests

Golden eagles and prairie falcons nest primarily in cliff habitats in southern Alberta. Cliff and hoodoo sites along the upper Milk River (including the North Milk River) are also commonly used for nesting by ferruginous hawks (Erickson 2000, Quinlan *et al.* 2003, Downey and Quinlan 2004 *in press*). As these nest sites are usually inaccessible to cattle, direct impacts to cliff nests are minimized. However, heavy use of riparian areas by cattle could have long-term indirect effects on cliff nest-site stability. Heavy trampling and browsing along riparian areas can lead to removal of woody vegetation and an altered plant community comprised of shallow-rooted exotic grasses (Fitch and Adams 1998). This type of severe modification can cause erosion and bank slumping which eventually alters channel morphology and can lead to increased velocity of streams and rivers (Fitch and Adams 1998). This has downstream consequences on bank stability and can result in increased erosion which ultimately leads to slumping, incisement or possible flooding of cliff-nest sites. Nest sites nearer to the base of cliffs are more susceptible to this type of damage. Although these types of effects are typically the result of other human impacts at the watershed level (*i.e.,* diversion of water, improper culvert sizes, damming or channeling of natural watercourses) cumulatively, localized impacts due to grazing at several points along the same riparian channel can have a significant effect.

C) Ground nests

Short-eared owls are one of the few prairie raptors that nest predominantly on the ground. Ferruginous hawks, Swainson's hawks, and golden eagles will also nest on the ground when suitable elevated structures are not available (Snow 1973, Dechant *et al.* 2001a,b). Ground nests are inherently susceptible to the direct and indirect consequences of grazing. Heavy grazing can reduce the availability of suitable grass cover required for nesting, particularly if stocking rates do not allow for sufficient carry-over of litter each year and do not account for periods of drought. Ground nests may also be susceptible to trampling particularly in intensively stocked pastures. As discussed earlier, ferruginous hawk ground nests in South Dakota were preferentially located in prairie that was unused or lightly grazed (Lokemoen and Duebbert 1976). Short-eared owls have also demonstrated a preference for nesting in lightly grazed or ungrazed fields (Dechant *et al.* 2001c).

2) Alteration of prey diversity and abundance

In general, small mammals show a varying degree of tolerance towards grazing (Kochert *et al.* 1988, Kochert 1989, Olendorff 1993). Grazing typically favours granivorous small mammals such as heteromyid (pocket mouse) and geomyid (pocket gopher) rodents, however, few prey species tolerate intensive long-term grazing (Kochert *et al.* 1988, Kochert 1989). Jones *et al.* (2003) suggest that a landscape with a mosaic of grass and shrublands and varying amounts of ground cover including relatively dense grasslands will likely maintain the highest diversity of rodents.

The habitat preferences and potential impacts of grazing on the primary prey species listed in Table III-1 are discussed below.

A) Richardson's ground squirrels

Richardson's ground squirrels are common throughout the Grassland Natural Region of Alberta. Ground squirrels are found in colonies and prefer flatter, upland, open areas of short and mixedgrass prairies with relatively short vegetation that allows them to detect predators (Michener 1996, 2002, Reynolds *et al.* 1999, Michener and Schmutz 2002). Soil type is a limiting factor as to where ground squirrels occur. Ground squirrels do not inhabit areas with loose sand or heavy clay soils (Reynolds *et al.* 1999). Richardson's ground squirrels are apparently able to survive in human-modified habitats such as in heavily grazed fields, at the edges of cultivated fields, perennial crops and in green spaces in urbanized areas (Michener 2002). However, according to a recent survey along thirty, 8 mile (12.9 km) transects randomly distributed in the Grassland Natural Region of Alberta, native prairie may offer preferred ground squirrel habitat (Downey 2003b, unpublished survey results). Out of a total of 796 ground squirrels counted during this survey, 571 (72%) were found on native prairie (n = 696); 128 (16%) were found in cultivated fields (n = 808); 58 (7%) in seeded pasture (n = 141); 32 (4%) in hay land (n = 15); and 7 (0.9%) in farmyards (n = 24). The majority of ground squirrels found in native prairie were in short vegetation (less than 10 cm); fewer were seen in taller vegetation. Although grazing use was not quantified during this study, these results indicate that ground squirrels appear to tolerate moderate to heavy grazing that results in short vegetation.

B) White-tailed jackrabbits and mountain cottontails

White-tailed jackrabbits are common throughout southern and central Alberta and typically occur in open areas and avoid dense forests (Pattie and Fisher 1999). Jackrabbits prefer upland habitats comprised of open grassland with intermittent shrubby cover (Reynolds *et al.* 1999). Mountain cottontails occur throughout the Grassland Natural Region of Alberta (Pattie and Fisher 1999). Their range does not extend beyond the northern limit of the Red Deer River. Unlike white-tailed jackrabbits, cottontails avoid open, coverless plains and prefer lowland wet areas such as cottonwood tree groves and shrubby ravines (Reynolds *et al.* 1999). Therefore, cover and edge habitat are described as important habitat features of mountain cottontails in Alberta (Pattie and Fisher 1999).

Flinders and Hansen (1975) found that white-tailed jackrabbits were not significantly affected by grazing intensity in the shortgrass prairie of northeastern Colorado. However, desert cottontail rabbits were most abundant in moderate-summer and moderate-winter grazing treatments in this study. Desert cottontail rabbits were most common in areas near to dense stands of shrubs, along edges between vegetation types or in areas with gullies or rocky outcrops. In Oklahoma, Great Plains jackrabbits (*Lepus californicus melanotus*) and pocket gophers (*Geomys breviceps llanensis*) were found to be more abundant in "moderately overgrazed" pastures, whereas Oklahoma cottontails (*Sylvilagus floridanus alacer*) were most abundant in undisturbed grasslands and least abundant in heavily grazed pastures (Philips 1936). Overall, rodent and lagamorph numbers were reduced in "heavily overgrazed" pastures in this study. In southern British Columbia, sagebrush habitats with at least 30% vegetative cover represented good habitats for mountain cottontails (Sullivan *et al.* 1989)

C) Meadow voles

Meadow voles occur throughout Alberta in a variety of habitats (Pattie and Fisher 1999). The number and survival rates of meadow voles have been found to increase with increasing grass cover (Adler and Wilson 1989, Peles and Barrett 1996, Reynolds *et al.* 1999, Lin and Batzli 2001). An aboveground herbaceous cover of 700 g/m^2 is sufficient to support high densities of meadow voles; however vole densities decline rapidly when cover values drop to less than 280 g/m^2 (Reynolds *et al.* 1999). Due to this preference for high amounts of vegetation cover, heavy grazing is likely detrimental to meadow voles. Unlike cottontails, studies have also shown that meadow voles are less abundant at wooded edges and increase in number in the prairie interior in grass and forb dominated habitats (Manson *et al.* 1999, Nickel *et al.* 2003). Within the Milk River area, meadow voles were found to rely to some extent on the tunnels created by Richardson's ground squirrels particularly in areas with low cover values (Salt 2000).

3) Changes in prey vulnerability

By reducing vegetation cover, grazing may improve the ability of raptors to detect and catch prey. Wakeley (1978) and Bechard (1982) discuss the effect of vegetative cover on the use of foraging sites by Swainson's hawks and ferruginous hawks, respectively. Wakeley (1978) and Bechard (1982) both found that the density of vegetation cover was more important than prey density in the selection of hunting sites by Swainson's and ferruginous hawks. Bechard (1982) found that Swainson's hawks did not hunt in cultivated fields until crop harvest, despite an abundance of prey in cultivated fields prior to harvest. In general, densely covered cropland offers better concealment of prey which thereby reduces prey availability and limits foraging efficiency. By concentrating hunting effort in areas with reduced vegetation cover and density, hawks are able to gather more food per unit of energy expended (Wakeley 1978). This theory explains why native prairie in comparison to dense cropland provides better quality foraging habitat to all prairie raptors. In addition, it can explain how grazing, by reducing vegetation cover and density, may offer improved foraging success to raptors by increasing the vulnerability of prey. However, these positive effects depend on the intensity and duration of grazing as prolonged heavy grazing can eventually lead to decreased species diversity and abundance of certain prey such as meadow voles (Kochert *et al.* 1988).

9 GRAZING SYSTEMS AND RAPTOR HABITAT MANAGEMENT

Table III-2 provides an overview of five pertinent grazing systems and their potential positive and negative implications to raptors and their habitat. A grazing system is a tool used to control the spatial distribution, timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003). Applied research is needed to properly assess the effects of various grazing systems on raptors in the Milk River Basin.

Table III-2 Grazing Systems and Raptor Habitat Management

Grazing System	Discussion
Continuous (Season-long) Grazing	
Advantages:	The potential advantages of continuous grazing systems to raptors depend on stocking rate, timing of grazing, and the effectiveness of techniques to distribute grazing use over the landscape. With light to moderate stocking rates, areas near water or salt or with more palatable grasses will receive heavier use than other areas. Formerly grazed patches will receive repeated use as these patches have a lesser build up of litter and higher cover of more palatable regrowth vegetation (Robertson *et al.*1991). Therefore, while cattle are not excluded from certain areas under continuous grazing, with stocking rates that ensure that only a moderate percentage of vegetation is utilized, grazing pressure across the rangeland will be variable. Variably grazed rangeland creates patches with varying litter cover and vegetation heights and also stimulates plant species diversity (Bai *et al.* 2001). Richardson's ground squirrels will benefit from shorter vegetation in moderate to heavily grazed patches (Downey 2003a, Downey 2004a), while lagomorph prey and meadow voles will benefit from the greater vegetation cover of lighter or ungrazed areas (Olendorff 1993). Therefore all primary raptor prey species can benefit from heterogeneous cover. In areas with less cover, prey vulnerability is increased allowing raptors to forage more efficiently (Wakeley 1978, Bechard 1982). Areas with less use and higher cover also offer protected ground nesting sites.
Disadvantages:	In the long-term, continuous grazing under heavy stocking rates has the potential to negatively impact foraging and nesting habitat for most raptors. Short-eared owls, as ground nesters and whose primary prey (meadow voles) prefer greater amounts of cover, may see immediate consequences of heavy grazing. Bock *et al*. (1993) suggested short-eared owls responded negatively to grazing in the Great Plains and western shrubsteppe. Other studies suggest short-eared owls required idle (ungrazed during the breeding season) grasslands or dense, tall vegetation for nesting (Duebbert and Lokemoen 1977, Kantrud and Higgins 1992, Dechant *et al.* 2001c). Raptors such as Swainson's and ferruginous hawks that rely on nest trees in riparian areas may also be negatively affected in the long-term by continuous heavy grazing. Riparian areas tend to suffer the most under continuous heavy use, particularly if alternate water sources or upland salt sites are not available. Heavy use of riparian areas leads to trampling and heavy browsing and ultimate elimination of woody species required for nesting. Heavy use of riparian area vegetation also limits their potential to provide habitat for numerous other birds and small mammals that rely on dense or woody cover and a diverse plant community.
Complementary Grazing	
Advantages:	Complementary grazing is a form of season-of-use grazing, with seeded pasture grazed earlier or later in the season than native prairie. The use of seeded pasture has the potential to improve the health of native rangeland by allowing periods of rest and recovery. Improved rangeland health allows for retained and increased litter cover and restored plant vigour of upland grassland and riparian areas and woody or shrubby draws. This has potential to improve the availability or sustainability of nesting cover and prey habitat for raptors. The benefits of complementary grazing, however, depend on whether marginal cropland can be converted to seeded pasture or if seeded pasture is available within the grazing operation. The interspersed tracts of seeded pasture is likely most beneficial to Swainson's hawks, as they use a variety of cover types for foraging and have a broader diet than ferruginous hawks and prairie falcons (Dechant *et al.* 2001b).
Disadvantages:	Conversion of large tracts of native prairie to monotypic seeded pasture has the potential to reduce the density and reproductive success of raptors by loss of nesting sites and possible reduction in the diversity or availability of prey populations (Howard and Wolfe 1976). Although further study is required, a recent survey suggests that Richardson's ground squirrels are significantly more common in native prairie than cultivated land or seeded pasture in southern Alberta (Downey pers. comm.). Therefore loss of native prairie has direct implications for the availability of primary prey for

Grazing System	**Discussion**
Complementary Grazing Cont'd.	
Disadvantages:	ferruginous and Swainson's hawks and prairie falcons. Ferruginous hawks, may be particularly affected by fragmentation of native prairie as they decline in abundance in areas with less than 50% native prairie cover (Schmutz 1989). Similarly, prairie falcons have been found to hunt primarily in native prairie (Hunt 1993). Monocultures may also have a negative effect on golden eagles if no patches of shrubby or woody cover vegetation are retained to support lagomorph prey species.
Rotational Grazing	
Advantages:	Deferred or rest rotational grazing systems have been recommended as a good tool for managing raptor habitat in general (Kochert *et al*. 1988, Kochert 1989). These systems have been specifically recommended for ferruginous hawks (Ensign 1983, Olendorff 1993) and short-eared owls (Kantrud and Higgins 1992, Herkert *et al.* 1999). Rotational grazing systems are preferred over other types of grazing strategies as they offer a means to create habitat diversity by enforcing periods of rest and recovery. Ensign (1983) recommended lower levels of grazing, under rest-rotation systems for managing ferruginous hawk habitats. Ensign (1983) suggested that rotational grazing systems create diversity by creating a distribution of heavy, moderate, light, and ungrazed pastures. Moderate and heavily grazed pastures increase the vulnerability of prey, while ungrazed or lightly grazed pastures provide refuge habitat and a stable prey population source. Ensign (1983) recommended low to moderate grazing levels to ensure sufficient food and cover for prey species, particularly during drought years. Kantrud and Higgins (1992) found that fields that were idled during the growing season had more short-eared owl nests than fields under long-term grazing. Skinner *et al.* (1996) found that deferred grazed native prairie in southeastern Alberta had the highest values for vegetative cover and were the most productive habitat type for small mammals. Another benefit of rotational grazing is that it offers a tool for riparian habitat management by being able to control the timing and intensity of use in riparian areas. Riparian habitat management is important for protection of nest trees and to prevent severe channel modification and potential impact to cliff nest sites. Periodic rest also allows for improved health of upland shrub or tree vegetation. Structurally, as rotational grazing requires the use of cross fencing, it offers numerous perch sites for raptors to use for territory defence or hunting.
Disadvantages:	If cattle are grazed beyond the 50% utilization point, rotational grazing can contribute to uniform grazing effects (Kobriger 1980). This is particularly common when rotation of cattle between pastures is based on set calendar dates rather than according to vegetation utilization. Uniform utilization of the range can have short term benefits to raptors by increasing the vulnerability of prey to predation and possibly by increasing the density of Richardson's ground squirrels. However, it does not encourage the heterogeneity that is required to maintain stable and diverse small mammal prey populations or offer protected ground or tree nesting sites.
Intensive Grazing	
Advantages:	High stocking rates for short periods encourages intense utilization of the range, forcing cattle to be less selective when grazing. By distributing animals into numerous small grazing units, there is rigid control over where and when cattle graze portions of the landscape. Following periods of intense grazing, the resulting shorter vegetation offers raptors the benefit of increased prey vulnerability. Short vegetation also creates conditions that may be favourable for Richardson's ground squirrels, which benefit from improved visibility and ability to detect predators (Michener 2002, Downey 2003a, Downey 2004a).

Grazing System	**Discussion**
Intensive Grazing Cont'd.	
Advantages:	Certain grasshopper species also flourish in more heavily grazed rangeland, offering an alternate prey source for Swainson's hawks in particular (Johnson *et al.* 1987). Holmes *et al.* (1979) collected more grasshoppers from heavily and very heavily grazed fescue grasslands than from lightly and moderately grazed lands. Similarly, Quinn and Walgenbach (1990) found that grazed mixedgrass prairie sites supported higher populations of obligate grass-feeding grasshoppers. As intensive grazing systems require the creation of numerous fenced units, this creates numerous perches for raptors.
Disadvantages:	Intensive grazing even for short periods can result in declines in range condition, lower root mass, lower vegetation densities, as well as soil compaction and reduced infiltration rates in mixedgrass and fescue prairie (Dormaar *et al.* 1989, Willms *et al.* 1993). Reduced vegetation cover results in a decrease in nesting cover for short-eared owls as well as reduced cover for their primary prey, meadow voles. Ground nesting cover in areas with sparse tall nesting structures, is also reduced for ferruginous and Swainson's hawks. In South Dakota, ferruginous hawks preferred to nest in lightly grazed or idle areas (Dechant *et al.* 2001a). Reduced cover also diminishes the quality of habitat for jackrabbits and cottontails. As grazing is non-selective under intensive grazing systems, upland and riparian woody vegetation is typically browsed more heavily than it would be with reduced stocking rates. Heavy browsing, rubbing and trampling weakens nest trees. Therefore, intensive grazing has evident short and long-term detriments to raptors particularly if periods of rest are insufficient.
Riparian Area Grazing	
Advantages:	In the dry prairies of southern Alberta, suitable nesting trees for golden eagles, Swainson's and ferruginous hawks are most likely to be found along streams, rivers, or wetland riparian edges. Riparian areas that are well managed through either rest-rotation, corridor fencing or riparian pasture systems are more likely to support healthy, diverse vegetation communities including deeply rooted woody species and large shrubs used for nesting. Healthy and diverse riparian vegetation also provides habitat to a diversity of small mammal and insect prey.
Disadvantages:	Other than mountain cottontails, the prey species listed in Table III-1 are predominantly found in open, grassland habitats. Thus, protection of riparian habitats should not compromise upland forage or cover for these species or diminish nesting cover for ground-nesting raptors.

10 BENEFICIAL MANAGEMENT PRACTICE RECOMMENDATIONS

Protection of prairie raptors including ferruginous hawks, Swainson's hawks, golden eagles, short-eared owls, and prairie falcons is contingent on maintaining suitable and secure (undisturbed) nesting habitat surrounded by good quality foraging habitat with an adequate and stable prey base. Although there is some variation in the nesting and dietary requirements of these raptors, stewardship of native prairie intermixed with shrubby draws and tree clumps as well as healthy riparian corridors will benefit all species.

The following general land use and grazing recommendations offer a variety of means to protect or enhance raptor habitat within the Milk River Basin and throughout the Grassland Natural Region of Alberta. Further research (Section 11) is required to improve our understanding of prairie raptors and their prey as well as the role of grazing as a tool for enhancing raptor habitat.

10.1 General Recommendations

Foraging Habitat:

- Protect remaining native prairie from cultivation (Olendorff 1993, Schmutz 1999, Dechant *et al.* 2001 a,b,c). In particular, maintain native prairie complexes within 20 km of major river valleys with suitable cliff nest sites for ferruginous hawks, golden eagles and prairie falcons (Hunt 1993, Quinlan *et al.* 2003). Ferruginous hawks require large areas of contiguous native prairie, while other raptors such as Swainson's hawks will use fragmented native prairie with between 11% to 30% cultivation (Schmutz 1984). Land managed for cattle grazing as the dominant land use is compatible with the protection of large tracts of native prairie.
- Remove marginal farmland from production, where possible, and seed with native species to enlarge habitat patches and reduce fragmentation for ferruginous hawks in particular.
- Reduce or avoid the use of insecticides and organochlorine pesticides including carbamates and organophosphates (Forsyth 1993, Baril 1993, Kirk and Hyslop 1998). Organochlorine pesticides such as carbofuran are considered extremely toxic to birds (Baril 1993). Raptors are especially vulnerable to poisoning through ingestion of contaminated prey carcasses (Baril 1993). The widespread use of organochlorine pesticides may also negatively affect raptor breeding success (Baril 1993).
- In areas with nesting populations of golden eagles or ferruginous hawks, maintain existing stands of native shrub and sagebrush communities ((Howard and Wolfe 1976, Olendorff 1993, Marzluff *et al.* 1997a). Large patches of shrub or sagebrush vegetation increases suitable lagomorph (rabbits and hares) prey habitat for these raptors (Marzluff *et al.* 1997a). Howard and Wolfe (1976) recommend leaving at least 20% of the total area in existing shrub, sagebrush or tree habitat to maintain foraging and breeding habitat for ferruginous hawks.
- Provide large, open grassland areas near to traditional ferruginous hawk, prairie falcon and short-eared owl nest sites (Holt and Leasure 1993, Olendorff 1993, Herkert *et al.* 1999, Dechant *et al.* 2001a,c).

- Maintain and restore the health of lotic (flowing water) and lentic (standing water) riparian habitats that support tree or shrub vegetation.
- Avoid ground squirrel control within a minimum of 15 km of raptor nests. Inform landowners about the beneficial ecological role of Richardson's ground squirrels and about preferred control techniques if control of this species is considered essential. If control is essential to protect agricultural values, lower the peaks of cyclic highs rather than eliminating entire local populations (Olendorff 1993). Strongly promote raptors as natural biological control agents.
- Fences and other tall structures such as scratching posts provide perching sites for raptors to hunt from.

Nesting Habitat:

- Protect traditional tree or cliff nest sites from human disturbance and heavy grazing (Olendorff 1993, Dechant *et al.* 2001a,b, Paton 2002). Security of nest sites is particularly important for prairie falcons due to their strong nest site fidelity and specialized nesting requirements (Paton 2002). Particular attention should be paid to protecting the North Milk and Milk Rivers (from the U.S. – Canada border downstream to the town of Milk River) from development or increased human disturbance (Quinlan *et al.* 2003, Downey and Quinlan 2004 *in press*). This area has significant nesting populations of ferruginous hawks and prairie falcons (Quinlan *et al.* 2003, Downey and Quinlan 2004 *in press*).
- Minimize human disturbance near known nest sites during the early nesting period (March 15 to July 15). This is especially important for ferruginous hawks due to their documented sensitivity to disturbance (Ensign 1983, Olendorff 1993, Dechant *et al.* 2001a). Increased human activities around river breaks and on the river which may disturb or displace nesting raptors is a particular concern for cliff nesters like prairie falcons, golden eagles and ferruginous hawks. "Wildlife Control Areas" (public exclusion areas) have proven to be an effective tool for protecting prairie falcon and golden eagle nest sites along the Oldman River Reservoir (Paton 2002).
- Abide by setback distances and timing restrictions recommended by SRD, Fish and Wildlife Division for human activities, including industrial development, near to raptor nests (SRD 2001b). SRD recommends a year-round setback of 1,000 m from ferruginous hawk, prairie falcon and golden eagle nests for high-impact developments such as wellsites, power lines and pipelines. SRD recommends a 400 m setback from short-eared owl nests between April 1 and July 31 for high-impact developments. Winter construction is preferred to minimize impacts to breeding raptors, provided there is an appropriate setback from nests.
- Conduct pre-development wildlife surveys to locate ferruginous hawk, prairie falcon, golden eagle and short-eared owl nests to plan developments in accordance with SRD setback guidelines. Surveys need only be conducted where suitable habitat for these species exists.
- Conduct land improvements such as brush removal, plowing or mowing during the non-nest season (*i.e.,* avoid these types of activities between March 1 to August 1) (Olendorff 1993).
- Maintain individual trees or interspersed tree stands in the landscape (Olendorff 1993, Dechant *et al.* 2001a,b,). The availability of suitably spaced trees affects the number of breeding buteos (such as ferruginous and Swainson's hawks). In Alberta, at least 4 small

clumps of trees per 2.6 km^2 of habitat are necessary to maximize nesting by the majority of buteos (Schmutz *et al.* 1980, Olendorff 1993).

- Leave dead or decadent trees standing (Olendorff 1993).
- Monitor the condition of nest trees and where necessary plant trees or reinforce dead or decadent nest trees (Olendorff 1993). Olendorff (1993) recommends reinforcing the bases of weak or unstable tree nests with wire mesh, netting or lumber as well as stabilizing or reinforcing snags that hold nests.
- Maintain shelterbelts around abandoned farmsteads and field edges for use by Swainson's hawks (Dechant *et al.* 2001b). Replace dead or dying trees along shelterbelts with native species such as cottonwoods.
- Maintain or restore the health of riparian forests. Cottonwood forests along the Milk River provide nesting habitat for golden eagles and Swainson's hawks in particular as well as to numerous other bird species. Although influenced by grazing, cottonwood forests require sufficient instream flow particularly during late spring and summer, as well as regular flooding events for seed dispersal and germination (Bradley and Smith 1986, Rood *et al.* 1995).
- Where natural cliff nest sites are jeopardized either by natural factors or human activities, investigate the potential to create artificial nest sites for prairie falcons (Paton 2002). Artificial cliff nest sites constructed for prairie falcons as part of the mitigation program for the Oldman River Reservoir were successfully occupied (Fyfe 1990). Artificial nest sites have also been successful at the Bassano Reservoir (Paton 2002).
- Human structures such as power lines or nesting platforms are frequently used for nesting by ferruginous hawks, in particular (Olendorff 1993).

Other:

- Various techniques have been suggested to reduce the risk of electrocution deaths among golden eagles in particular. These include promoting the use of low-profile and enclosed transformers; providing a minimum of seven feet of space between phase conductors and ground wires on all lines; and installation of perches at poles where multiple bird deaths have occurred (Snow 1973).

10.2 Grazing Recommendations

Grazing systems that will benefit raptors should perform the following functions:

- maintain or enhance the quality and availability of nesting substrate; and
- increase the vulnerability of prey to raptor predation while maintaining a diversity of cover types to promote the diversity, abundance, and long-term stability of prey populations.

Selection of a suitable grazing system is dependent on local environmental conditions and the types of raptors that are being managed for. Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR). Grazing strategies that promote heterogeneous vegetation cover and retain native prairie landscapes with mosaics of shrub or tree patches will benefit a wide range of prairie raptors. Creating heterogeneity across the landscape requires control of timing of grazing, stocking rates, and cattle distribution.

The following grazing recommendations discuss key management principles that will benefit all prairie raptors. Specific recommendations for individual species are also given.

- Promote heterogeneous vegetation heights by encouraging light to moderate grazing at suitable proper use factors for fescue (40%) and mixed grass prairie (50%) (Adams *et al.* 1994).
- Use an appropriate stocking rate and proper percentage of vegetation utilization to ensure sufficient carry-over and maintained plant vigour and range condition.
- Track annual grazing capacities; vary stocking rates and distribution in accordance with drought events and range condition.
- Patch grazing with areas of heavy grazing and other areas of light to moderate grazing will benefit most raptor prey. Ground squirrel density and vulnerability is increased in shorter vegetation (Downey pers. comm., Michener and Schmutz 2002). Taller cover provides preferred habitat for lagomorph prey and for meadow voles, the primary prey of golden eagles and short-eared owls, respectively.
- Avoid intensive grazing systems with high density stocking rates over large areas and retain areas with taller vegetation cover (20 cm to 40 cm) to provide ground nesting habitat for short-eared owls, ferruginous and Swainson's hawks (Holt and Leasure 1993, Herkert *et al.* 1999).
- Use deferred or rest rotational grazing to improve ground nesting habitat for short-eared owls and ferruginous hawks, in particular (Ensign 1983, Kochert *et al.* 1988, Kochert 1989, Kantrud and Higgins 1992, Olendorff 1993, Herkert *et al.* 1999).
- Manage and monitor cattle use of upland woody vegetation to ensure trees and shrubs are healthy and capable of regenerating. Upland shrub patches provide lagomorph prey habitat, while trees provide nesting habitat for many raptor species. Temporary fencing may be needed to mitigate heavy use of nest trees in arid landscapes with scarce woody cover (Olendorff 1993).
- Implement riparian grazing systems to maintain diverse vegetation cover for small mammal prey species and to maintain a varied age class of trees to provide long-term nesting opportunities for raptors.
- The optimal time of use of riparian areas is during the summer after spring runoff when the stream banks are no longer soft, and before the dormant season (Fitch and Adams 1998). This also reduces disturbance near raptor nests early in the nesting season.
- Distribute salt away from riparian areas and shrubby or woody draws to reduce impact to these areas and encourage better utilization of the range.
- Develop upland stockwater, where necessary, to control heavy use of riparian areas.

- Ensure cattle access trails along river banks do not impact ferruginous hawk, prairie falcon or golden eagle nest sites along slopes.
- Deferred-rotation, rest-rotation, riparian pasture and corridor fencing have been suggested as techniques for improving the health of riparian areas (Fitch and Adams 1998). Several years of rest may be required where the goal is to regenerate new trees like cottonwoods (Fitch and Adams 1998).

11 RESEARCH RECOMMENDATIONS

Few quantitative studies have assessed the effect of grazing and different grazing strategies on raptors and their habitats (Olendorff 1993). Continued monitoring of raptor populations, their primary prey, and changes in land use and grazing intensity over time is necessary. This type of monitoring is currently ongoing with respect to ferruginous hawks and Richardson's ground squirrels in the Grassland Natural Region of Alberta (Downey 2003a, Taylor 2003). However, similar research is lacking for prairie falcons, short-eared owls, and golden eagles (Clayton 2000). There is a need for improved survey protocols and more consistent monitoring of core populations of these species to provide a reliable index of population and productivity trends (Paton 2002). Foraging habitat use by short-eared owls and golden eagles in Alberta also requires further study.

With respect to grazing and raptors, specific questions to be addressed include:

- Is there a significant difference between raptor densities or reproductive success in habitats managed under continuous versus rotational grazing systems?
- How does grazing intensity affect raptor prey species composition, density, and long-term stability?
- What is the frequency of foraging attempts by raptors in grazed versus ungrazed habitats?
- How does range or riparian health correspond with raptor productivity or density?

Due to their importance as a major prey species for the majority of raptors, additional scientific research to evaluate the habitat preferences of Richardson's ground squirrels would be valuable (Michener pers. comm.). Little is known about the response of ground squirrels to habitat fragmentation or the relative stability and abundance of populations in shorter versus taller vegetation. Additional research is also required to determine how many ground squirrels are needed to support a productive population of prairie falcons (Paton 2002). The relative importance of ground squirrels as secondary prey for golden eagles also requires further study.

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B. SHARP-TAILED GROUSE

1 INTRODUCTION

1.1 Background

The purpose of this report is to summarize the ecology and critical habitat needs of the plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) in southern Alberta. Based on this information and supporting scientific studies, the potential effects of livestock grazing on this species and its habitat is discussed. This discussion is followed by a summary of recommended beneficial management practices to enhance sharp-tailed grouse habitat in the Milk River Basin in Alberta, with broader application to the range of this species within the Grassland Natural Region of Alberta (Alberta Environmental Protection 1994). Lastly, a brief summary of research recommendations is provided.

Increased agricultural production, the loss of native prairie habitat and intensive livestock grazing have contributed to a decline in sharp-tailed grouse populations in Alberta and across their range in North America (Millar 1999, Giesen and Kobriger 1997). By the mid 1990's, population trend data for sharp-tailed grouse in Alberta indicated population declines ranging from 50 to 70 percent in some areas over the last 30 years (Goddard 1995, Jones and Lee 2000). Sharp-tailed grouse are currently considered a "Sensitive" species in Alberta that may require special attention in the future to prevent it from becoming at risk of extirpation (Alberta Sustainable Resource Development (SRD) 2001a).

1.2 Ecology

During the spring breeding season, male sharp-tailed grouse gather and perform ritual courtship displays on "leks" or "dancing grounds". According to research conducted in the aspen parklands of Saskatchewan, late April to approximately May 15th is described as the period of female lek visitation, highest male visitation, and greatest activity on the lek (Pepper 1972). Breeding displays typically occur for about 2.5 to 3.5 hours in the morning, beginning 30 to 40 minutes before sunrise, and again for about 1.5 hours before sunset (Pepper 1972).

Female grouse begin to construct a nest scrape at approximately the same time or before visiting dancing grounds in the spring (Millar 1999). The timing of nesting and breeding is affected by snowfall, with earlier nesting dates recorded in years of little snow in March and April, and later nesting dates found when snow persists into April (Bergerud and Gratson 1988). Sharp-tailed grouse have an average clutch of 12 eggs (Amman 1957). Eggs are laid daily and the 23 to 24 day incubation period begins after the last egg is laid (Millar 1999). Hatching occurs from the first of June to the middle of July, with peak hatching occurring during approximately the second or third week of June (Pepper 1972). Grouse chicks are precocial and leave the nest shortly after hatching in search of brood rearing habitat. Chicks are capable of flying to some degree by 10 days of age, and disperse from the brood when they become fully independent at six to eight weeks (Millar 1999).

1.2.1 Diet

Sharp-tailed grouse are omnivorous and consume fruits, green leaves, buds and insects (Millar 1999). Food is not considered limiting to grouse populations or breeding densities (Bergerud 1988). The vegetation used by grouse for cover is typically also used for food, with cover value often selected over forage value (Beregrud 1988, Millar 1999). Table III-3 provides a brief description of typical sharp-tailed grouse diets at different life stages and seasons of the year.

Table III-3 Sharp-Tailed Grouse Diet

Grouse Life Stage and Season of Year	**Dietary Description**
Chick Diet	▪ Insects including grasshoppers, beetles and ants comprise the dominant diet of chicks for their first two weeks of life. ▪ At 12 weeks of age, chick diets resemble adult diets, consisting of approximately 90% plant material (Millar 1999).
Adult Spring Diet	▪ Favoured spring forage includes aspen catkins, new forb growth such as dandelions (*Taraxacum* spp.) and remaining available fruits from the previous season (Millar 1999).
Adult Summer Diet	▪ In the Nebraska sandhills, summer sharp-tail grouse diets consisted of 91% plant material and 5% insects (Kobriger 1965). ▪ Important summer forages include clover (*Trifolium* spp.), rose (*Rosa* spp.) and dandelion.
Adult Fall and Winter Diet	▪ Woody plant fruits, seeds, buds and leaves from hawthorn (*Crataegus* spp.), rose, western snowberry, common chokecherry (*Prunus virginiana*), saskatoon (*Amelanchier* spp.), currant (*Ribes* spp.), Russian olive (*Eleagnus angustifolia*), creeping juniper (*Juniperus horizontalis*), cotton wood (*Populus* spp.) and aspen (*Populus tremuloides*) constitute the majority of fall and winter diets (Millar 1999). ▪ Where waste grains from croplands are less than 50 m from woody cover, grain is also consumed during the winter (Millar 1999).

1.2.2 Predators

Sharp-tailed grouse and their nests are vulnerable to predation from numerous types of raptors, corvids (crows, jays, magpies and ravens) and mammalian predators such as red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), striped skunks (*Mephitis mephitis*) and weasels (*Mustela* spp.) (Millar 1999).

1.3 <u>Habitat Requirements</u>

1.3.1 General

A mosaic of plant communities including native grassland and shrub mixtures with extensive ecotone are considered important habitat components for maintaining sharp-tailed grouse populations (Pepper 1972, Moyles 1981, Swenson 1985). Consequently, native prairie cover and percent shrub cover were the two variables included in the habitat suitability index (HSI) model for the plains sharp-tailed grouse in the Milk River Basin (Jones 2004). Areas with 75% to 100% native prairie cover and between 5% to 15% shrub cover were rated as highly suitable habitat for sharp-tailed grouse. Native prairie cover represents nesting, hiding and brood rearing habitat while shrub cover represents a component of nesting and winter habitat. Based on this model, the two largest areas with the greatest habitat potential for sharp-tailed grouse in the Milk River Basin are the Milk River Ridge to the west and the Sage Creek area in the southeast (Jones 2004).

1.3.2 Lek (Dancing Ground) Site

Sharp-tailed grouse leks or dancing grounds are commonly characterized by low, sparse vegetation that allows for good visibility and uninhibited movements (Millar 1999). Leks are most often located on a slight rise such as a low ridge or knoll or in open flat areas that provide "wide-viewing horizons" in all directions (Baydack 1988, Millar 1999). The stability and availability of surrounding suitable nesting habitat is also an important factor in the establishment and consistency of use of leks (Bergerud and Gratson 1988). Availability of food, roosting, loafing and escape cover in the vicinity are other determinants of lek location and occupancy (Pepper 1972, Millar 1999).

1.3.3 Nesting Habitat

Roersma (2001) found that sharp-tailed grouse nests were an average distance of 1.1 km from the lek in the Milk River Ridge area. Preferred sharp-tailed grouse nesting habitat includes lush and dense residual growth of grass-sedges in association with short shrubs such as rose (*Rosa* spp.) and snowberry (*Symphoricarpos occidentalis*) (Pepper 1972, Millar 1999, Roersma 1999). Treed bluffs are not typically used as nesting habitat (Millar 1999). Vegetation heights greater than 24.5 cm but less than 6 m are used for nesting (Christenson 1970, Pepper 1972). A minimum cover height of 30.5 cm, a high percentage of overhead cover (75%) and a minimum average Visual Obstruction Reading (VOR)[1] of 1.5 dm have been noted as spring sharp-tailed grouse nesting requirements (Amman 1957, Christenson 1970, Kobriger 1980). Roersma (2001) noted that sharp-tailed grouse nests on the Milk River Ridge contained more woody (shrub) cover and less graminoid cover than random sites. More research is needed to assess the effect of litter cover thresholds and sharp-tailed grouse nesting success. Thresholds of less than 25% litter cover and greater than 25% grass cover have been identified as predictors of increased nest success in greater prairie chickens in Missouri (McKee *et al.* 1998).

1.3.4 Brood Rearing Habitat

Grouse chicks require a high-protein diet of primarily insects during the first two weeks of their lives (Bergerud and Gratson 1988). During this critical period chicks cannot thermoregulate and must find suitable foraging habitat within close proximity of the nest site (Bergerud and Gratson 1988). To accommodate the high protein dietary requirements of chicks, broods use a greater variety of plant cover types than nesting hens and prefer warm, more open areas with a higher

[1] A Visual Obstruction Reading is determined using a Robel pole by recording the lowest 0.5 dm mark visible on the pole. Readings are taken north, east, south and west of the pole at a distance of four meters and at an eye level of one meter (Robel *et al.* 1970).

percentage of forbs and insects (Pepper 1972, Bergerud 1988). During the day, broods typically use less dense cover in the early morning and evening but seek areas of taller vegetation and more dense grass or woody cover at midday (Pepper 1972, Christenson 1970, Moyles 1981). Broods benefit from a mosaic of cover types including non-use grasslands, edges of heavily grazed pastures and woody draws (Christenson 1970). Roersma (2001) noted that brood rearing sites in the Milk River Ridge area had greater grass cover and reduced litter cover than random sites.

1.3.5 Roosting and Winter Cover

When snow conditions permit, sharp-tailed grouse will tunnel into snowdrifts to shelter from strong winds and severe winter temperatures (Millar 1999). Woody cover including aspen bluffs and shrubby or riparian hardwood draws also provide essential thermal cover for grouse during cold winters as well as concealment from predators (Swenson 1985, Giesen and Connelly 1993).

1.3.6 Area Requirements

The minimum amount of contiguous suitable habitat that is required before an area will be occupied by a sharp-tailed grouse population constitutes the “minimum habitat area” (Prose 1987). The minimum habitat area required by grouse populations will inevitably vary according to the quality and structure of available vegetation cover and with varying predator densities (Bergerud 1988). Kobriger (1980) calculated the minimum habitat area for sharp-tailed grouse in North Dakota to be a 5.3 km^2 circle based on a radius of 1.3 km, with the lek considered the central point of activity. The radius of 1.3 km was defined according to the mean distance from known leks to nest sites. In the aspen parklands of Saskatchewan, Pepper (1972) determined that a minimum of 0.24 km^2 of suitable grassy and/or shrubby vegetation around a lek was needed to attract an average of 6 male sharp-tailed grouse. However, to consistently attract a viable male population to leks each spring, Pepper (1972) proposed that between 1.6 km^2 to 3.2 km^2 of suitable surrounding vegetation was necessary. Roersma (2001) calculated the average total nesting area for five sharp-tailed grouse leks in the Milk River Ridge area to be 148.1 ha.

1.4 Sharp-Tailed Grouse Response to Grazing

Livestock grazing has the potential to impact sharp-tailed grouse due to removal of vegetation cover, alteration of plant species composition and potential trampling of eggs and nests. Changes in vegetation cover and plant species composition can have beneficial or detrimental impacts to the availability of plant or insect food sources and the quality of sharp-tailed grouse nesting, foraging, escape or wintering cover. In general, heavy grazing for prolonged periods can have a negative impact on critical sharp-tailed grouse breeding and wintering habitats (Pepper 1972, Nielsen 1981, Giesen and Connelly 1993). Light to moderate grazing is considered more appropriate for sustaining the quality of sharp-tailed grouse habitats (Nielsen 1981). Light to moderate stocking rates allow for the retention of residual grass cover and shrub patches that provide important nesting and escape cover. It is especially important to minimize the impacts of livestock to leks and surrounding nesting cover during the breeding season as well as to minimize impact to riparian areas (Giesen and Connelly 1993).

1.5 Grazing Systems and Sharp-Tailed Grouse Habitat Management

Several studies have examined the effects of various grazing systems on the habitat needs and reproductive success of sharp-tailed grouse (Kobriger 1980, Mattise *et al.* 1981, Nielsen 1981, Grosz 1985, Sedivec *et al.* 1990, Kirby and Grosz 1995). The results of these studies are summarized in Table III-4. Overall, no one grazing system was unanimously preferred. Stocking rate and the timing and distribution of cattle are considered decisive factors influencing the potential benefits or detriments of each grazing system.

Table III-4 provides an overview of eight grazing systems and their potential positive and negative implications to sharp-tailed grouse and their habitat. A grazing system is a tool used to control the spatial distribution, timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003). Applied research is needed to properly assess the effects of various grazing systems on sharp-tailed grouse in the Milk River Basin.

Table III-4 Grazing Systems and Sharp-tailed Grouse Habitat Management

Grazing System	Discussion
Continuous (Season-long) Grazing	
Advantages:	Under moderate stocking rates, continuous grazing often leads to patch grazing effects in fescue prairie and to a lesser extent in mixedgrass prairie, with areas that are consistently reused and areas that receive little use. Patch grazing is typically the result of continuous grazing where forage supply exceeds livestock demand (Spedding 1971). Variably grazed patches help to create a heterogeneous habitat mosaic. Ungrazed or less used patches offer suitable nesting, roosting and escape cover. Grazed patches will typically stimulate increaser forb growth and may offer microsites for insect production. Studies have shown that several grasshopper species are more numerous in heavily grazed areas and prefer ranges with sparse grass stands and a high forb component (Holmes *et al.* 1979, Holechek *et al.* 2003). The shorter vegetation of grazed patches near to taller thicker cover is ideal foraging habitat for grouse chicks that may otherwise be inhibited by dense vegetation or thick litter. Roersma (2001) noted that brood rearing sites had less litter cover than random sites in the Milk River Ridge area. Kobriger (1980) recommended season-long grazing at moderate stocking rates that allow a 50% utilization rate as a strategy to prevent uniform grazing and promote vegetation heterogeneity for sharp-tailed grouse in mixedgrass prairie of North Dakota. Nesting hens in this study demonstrated a preference for grassy upland habitats. When quantity and quality of surrounding grasslands was low, grouse were observed to nest in shrubby lowland draws. Mattise *et al.* (1981) noted that the average height and density of vegetation was significantly greater in their season-long gazing system compared to their deferred-rotation system. In this study, conducted in the mixed grasslands of North Dakota, grazing rates averaged 2.3 acres per animal unit month, and pasture sizes averaged approximately 605 acres (Mattise *et al.*1981).
Disadvantages:	Continuous grazing under intensive stocking rates can have obvious detrimental impacts to sharp-tailed grouse habitat by creating uniformly heavily grazed conditions. Lack of adequate carry-over and uniform grazing decreases nesting, foraging and escape cover for grouse. In addition, riparian areas are often heavily impacted by persistent cattle use under continuous grazing systems particularly if alternate water supplies or fencing is not in place. Persistent use of riparian areas can eliminate deciduous trees or shrubby vegetation that form an important part of sharp-tailed grouse winter habitat.
Deferred Grazing	
Advantages:	Deferred spring grazing has the obvious advantage of minimizing possible grazing or trampling disturbance to nesting or breeding grouse during a critical time of year. Deferring grazing early in the season, particularly in fescue prairie, would have the added advantage of improved plant vigour and sustained productivity (Willms and Fraser 1992). Pepper (1972) suggests that the carrying capacity for sharp-tailed grouse is limited by the availability of large acreages of ungrazed grass-shrub and hayland within 1.6 km of a lek. Deferred spring grazing would therefore provide grouse with ungrazed or lightly grazed areas within proximity to the lek during the nesting season (Millar 1999). Deferred spring grazing was found to be mutually beneficial to livestock, waterfowl and sharp-tailed grouse production in a study conducted at the Central Grasslands Research Center in south central North Dakota (Kirby and Grosz 1995).
Disadvantages:	The potential advantages of deferred grazing for enhancing sharp-tailed grouse habitat depend on the period of deferment, the intensity of grazing and the degree of carry-over that remains after the grazing season. Grazing later in the season could affect the amount of cover available to grouse early the next season if grazing is intense and residual carry-over material is not retained.

Grazing System	**Discussion**
Complementary Grazing	
Advantages:	As with deferred grazing systems, complementary grazing allows for undisturbed residual nesting cover and limits disturbance to grouse during nesting and brood-rearing. Deferred grazing pressure early in the season, as mentioned, can improve the health, productivity and sustainability of fescue grasslands in particular. Based on the results of a six year study, Prescott and Wagner (1996) concluded that complementary grazing in combination with rotational grazing improved range condition, grass yields and litter reserves in native prairie. These improvements were noted to provide a mosaic of habitats suitable for a wide spectrum of upland nesting birds.
Disadvantages:	Complementary grazing is particularly beneficial if existing cropland or hayland can be converted to permanent cover grassland pasture. However, if a complementary grazing system is established by converting native prairie, the benefits of this system may be outweighed by the loss of higher quality native habitat (Pepper 1972, Prescott and Wagner 1996). The value of seeded pasture as sharp-tailed grouse habitat is dependent on the size of the pastures in relation to surrounding native prairie and the amount of woody vegetation that is retained (Pepper 1972, Moyles 1981, Swenson 1985).
Season-of-Use Grazing	
Advantages:	Season-of-use grazing has good potential to enhance sharp-tailed grouse habitat for ranching operations that encompass mixedgrass and fescue prairie. The best season-of-use for mixedgrass prairie is in late spring and early summer, while fescue grassland benefits from later season grazing in late summer, early fall or winter. This type of grazing operation would likely result in improved range condition and would have the potential to provide good quality undisturbed residual nesting cover early in the season (Pepper 1972, Giesen and Connelly 1993, Millar 1999).
Disadvantages:	As with all other grazing systems, the stocking rate and percentage of vegetation utilization will influence its benefit to range condition improvement and grouse habitat enhancement.
Rotational Grazing (General)	
Advantages:	Rotational grazing systems including switchback, deferred-rotation and rest rotation grazing allow for timed sequences of grazing and rest periods in smaller sized pastures (Holechek *et al.* 2003). Rotational grazing reduces selective grazing by encouraging use of plant groups differing in their season of growth and allows for seed production, seedling establishment and restored plant vigour (Adams *et al.* 1991). Enforcing periods of rest allows undisturbed areas with residual vegetation to be retained and thereby promotes nesting habitat for sharp-tailed grouse. Periods of rest are also beneficial to minimizing disturbance to grouse during critical periods. Rest periods and periodic deferred early-season grazing can also promote the recovery of riparian areas and riparian plant communities that would otherwise receive consistent heavy grazing pressure. Riparian plant communities are important foraging, winter and escape cover for sharp-tailed grouse.
Disadvantages:	A noted disadvantage due to rotational grazing, is the creation of uniform grazing effects due to improved cattle distribution. Uniform grazing effects are accentuated when high stocking rates are used, forcing cattle to use the entire area available for grazing. As sharp-tailed grouse favour a mosaic of vegetation structure to provide them with suitable shelter, nesting and foraging habitats, uniform grazing effects can be detrimental to their productivity and survival. The creation of uniform grazing effects can be controlled if stocking rates are reduced.
Deferred and Rest Rotation Grazing	
Advantages:	Deferred-rotational grazing was recommended over other types of grazing systems as an effective means of providing upland bird nesting cover while also optimizing beef production per acre in two comparative studies in the mixedgrass prairie of North Dakota (Sedivec *et al.* 1990). Sedivec *et al.*

Grazing System	**Discussion**
Deferred and Rest Rotation Grazing Cont'd.	
Advantages:	(1990) found the greatest number of grouse nests (51%) in the twice-over deferred-rotation grazing system. (Twice-over grazing involves two rotations through a field in one season). All nests that were found during this study were initiated before the grazing season began (fourth week in May) or were in ungrazed pastures during rotations (Sedivec *et al.* 1990). Deferred-rotation pastures were grazed at a stocking rate of 2.7 AUM/ ha in this study. Sedivec *et al.* (1990) recommended deferred-rotational grazing as a means of promoting the maximum amount of undisturbed cover available for nesting upland birds until early July. In a similar study, Grosz (1985) also recommended twice-over deferred-rotational grazing to promote nesting cover for grouse. Twice-over deferred-rotation pastures promoted nesting habitat as they had 60 percent of the vegetation in Visual Obstruction Readings (VOR's) of 1.5 dm or greater (Grosz 1985). Grosz (1985) found 70 percent of the nests in his study were located in vegetation with a VOR of 1.5 dm or greater.
Disadvantages:	Kobriger (1980) suggests that deferred-rotational grazing contributes to uniform grazing effects as cattle are often grazed beyond the 50 percent utilization point. This occurs when movement between pastures is based on calendar dates and not vegetation utilization. Similarly, Mattise *et al.* (1981) caution that deferred rotation grazing may intensify use and reduce cover in areas of a pasture that would normally only be lightly grazed under season-long grazing. Nielsen (1981) noted that at high stocking rates, rest-rotational grazing can concentrate grazing effects and reduce the cover value of woody draws and reduce nesting cover close to leks. Nielsen noted that despite heavy grazing pressure, grouse did not move from their traditional use areas. Nielsen concluded that despite the benefits of better quality habitat in the rest pasture, these benefits may not exceed the harmful effects of the intensive grazing on the other three pastures as grouse did not adjust their use areas in relation to changing grazing pressures.
Intensive Grazing	
Advantages:	Seasonal intensive grazing can be beneficial if it occurs in an area of low quality or low use sharp-tailed grouse habitat (such as seeded pastures), and it is used to defer spring use of other native fields with lek sites.
Disadvantages:	The negative impacts of overgrazing and intensive grazing by cattle on sharp-tailed grouse habitat are well documented (Sisson 1970, Pepper 1972, Nielsen 1981, Giesen and Connelly 1993). Intensive livestock grazing for prolonged periods or early in the season is harmful to sharp-tailed grouse habitat by reducing necessary cover for nesting, shelter, roosting and winter foraging. Excessive trampling, grazing and browsing near to leks and riparian areas is especially detrimental to grouse habitat. High stocking rates are particularly damaging to fescue grasslands.
Riparian Area Grazing	
Advantages:	Grazing systems that are designed to control and minimize livestock impact of riparian areas will have benefits to improving sharp-tailed grouse habitat. Reduced pressure on riparian areas with forests and shrubs will provide higher quality fall and winter cover and foraging habitat for grouse. Pepper (1972), Moyles (1981), Nielsen (1981), Swenson (1985) and Giesen and Connelly (1993) all comment on the importance of protecting riparian areas from excessive overgrazing by livestock due to the importance of riparian area shrubs and trees as grouse habitat. Grazing systems that benefit riparian health limit cattle use of riparian areas during their most vulnerable periods, including spring when stream banks are soft, and autumn when riparian vegetation is more palatable than upland vegetation.
Disadvantages:	The benefits of riparian grazing systems depend on planning fencing and placement of alternate water sources to avoid concentrating cattle use close to leks or in suitable nesting habitat early in the season.

1.6 Beneficial Management Practice Recommendations

The following beneficial management practices are recommended to protect important sharp-tailed grouse habitat components in the Milk River Basin and to prevent disturbance to grouse during critical periods. These recommendations should be reviewed and amended as additional knowledge becomes available. A "breeding complex" encompassing all land within a 2 km radius of a lek was recommended as the management unit for Columbian sharp-tailed grouse (*T.P. Columbianus*) (Giesen and Connelly 1993). For the Milk River Ridge, Roersma (2001) suggests a management unit referred to as the "total nesting area", an area that encompasses all nests associated with a lek. Roersma (2001) calculated the average total nesting area for five leks to be 148.1 ha.

1.6.1 General Recommendations

- Protect remaining native prairie from cultivation or development.
- Limit disturbance within a minimum 148 ha total nesting area around leks during the breeding and nesting season (March to June) (Baydack1987, Giesen and Connelly 1993, Roersma 2001). Sharp-tailed grouse can be displaced from leks due to human disturbance (Baydack 1987). Disturbance to leks during the breeding and nesting season can, therefore, negatively impact sharp-tailed grouse reproductive success.
- Abide by setback distances and timing restrictions recommended by SRD, Fish and Wildlife Division for human activities, including industrial development, near to sharp-tailed grouse leks (SRD 2001b). SRD recommends a year-round set back of 500 m from sharp-tailed grouse leks for high-impact developments such as wellsites, powerlines and pipelines.
- Conduct pre-development wildlife surveys to locate sharp-tailed grouse leks in order to plan developments in accordance with SRD setback guidelines. Surveys need only be conducted in areas with suitable grouse habitat.
- Practice zero tillage of croplands and retain stubble fields within 1 km of woody draws or breaks to provide grouse with an alternate winter food supply (Giesen 1985, Goddard 1995).
- Use flushing bars and delay mowing of haylands within 1.6 km of active leks until mid-July to allow nesting hens with broods to fledge successfully (Goddard 1995).
- Promote organic farming practices and minimize the use of pesticides within 1.6 km of active leks. Pesticides can have direct impacts on grouse survival and reproduction and can result in reduced insect and plant food sources (Millar 1999).
- Retain shrubby and woody draw vegetation mosaics across fields and within the total nesting area (Moyles 1981, Roersma 2001).
- Reclaim disturbed native vegetation where possible and revegetate heavily impacted riparian corridors or woody draws.

1.6.2 Grazing Recommendations

Final decisions regarding the type of grazing system and calculation of suitable stocking rates that would best benefit sharp-tailed grouse need to be made on a case by case basis. Local conditions need to be considered including vegetation type, range condition and health, distribution of valued habitat components and dispersion of lek sites across the landscape. No one grazing system can be universally applied, and each must be tailored to local environmental conditions (Guthery 1995). Control and flexibility over stocking rates and dispersion of livestock use are two key properties of an optimum grazing system (Guthery 1995). Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

Grazing systems designed to enhance sharp-tailed grouse habitat should recognize the importance of native grass and shrubs as key habitat components for maintaining viable grouse populations. In addition, monitoring and managing lek sites and surrounding nesting habitat should be a priority.

The following grazing management principles should be applied to maintain habitat for sharp-tailed grouse:

- Limit disturbance within a minimum 148 ha total nesting area around leks during the breeding and nesting season (March to June) (Baydack1987, Giesen and Connelly 1993, Roersma 2001).
- Defer grazing during the spring breeding and nest initiation periods (March to late May) (Sedivec *et al.* 1990, Kirby and Grosz 1995). Where possible, a grazing commencement date of mid-June is recommended to avoid grazing disturbance during breeding, nesting and peak hatching (Pepper 1972).
- Provide sufficient residual grass and shrub cover within the breeding complex (Roersma 2001, Giesen and Connelly 1993, Millar 1999).
- Use an appropriate stocking rate and proper percentage of vegetation utilization to ensure sufficient carry-over and maintained plant vigour and range condition (Pepper 1972, Kobriger 1980, Mattise *et al.* 1981). Apply light to moderate stocking rates, and a proper use factor of 40% and 50% for fescue, and mixedgrass and dry mixedgrass prairie, respectively (Adams *et al.* 1994).
- Make seasonal adjustments in stocking rates based on fluctuations in precipitation and time of use and range condition.
- Avoid intensive, high stocking rate grazing systems and discourage uniform utilization of pastures (Pepper 1972, Sisson 1975, Kobriger 1980, Mattise *et al.* 1981).
- Create heterogeneous habitat with areas of varying species diversity and a gradation of short to tall and dense to light residual vegetation and litter cover (Sisson 1975, Kobriger 1980).
- Encourage periods of rest and defer early-season grazing in fescue prairie to improve range condition (Grosz 1985, Sedivec *et al.* 1990).

- Base rotational grazing systems on percentage of vegetation utilization and not scheduled calendar dates (Kobriger 1980).
- Convert cropland to permanent cover seeded pasture and implement complementary grazing where practical (Prescott and Wagner 1996).
- Manage livestock grazing in riparian areas to protect riparian shrubs and deciduous trees (Pepper 1972, Moyles 1981, Nielsen 1981, Swenson 1985 and Giesen and Connelly 1993).
- Fence out or minimize livestock use in woody vegetation considered to be critical grouse wintering habitat (Goddard 1995).
- Develop strategic permanent salting locations away from leks, stockwater and woody draws. Continuously move salt throughout the grazing season. Avoid placing salt or water facilities within a 148 ha total area around leks during the breeding and nesting season (March to June).
- Monitor and maintain records of active leks and range condition as well as yearly grazing records including livestock numbers, class, breed, take-in and take-out dates.

1.7 Research Recommendations

Due to its importance as an upland game bird, the ecology, habitat requirements and effects of grazing on sharp-tailed grouse have been fairly well studied. Most recently, Roersma (2001) examined the nesting and brood rearing ecology of plains sharp-tailed grouse in the Milk River Ridge area in Alberta. Further studies could be done to assess the effect of litter cover thresholds on sharp-tailed grouse nesting success. Evaluating the success of initiatives such as the Alberta Conservation Association Sharp-tailed Grouse Habitat Program would also be beneficial.

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C. MOUNTAIN PLOVER

1 INTRODUCTION

1.1 Background

The purpose of this report is to summarize the ecology and habitat requirements of the mountain plover (*Charadrius montanus*) in southern Alberta. Based on this information and supporting scientific studies, various grazing systems are compared in terms of their potential implications for maintaining or enhancing mountain plover habitat. This discussion is followed by a summary of recommended beneficial management practices to enhance mountain plover habitat in the Milk River Basin in Alberta. Lastly, a brief review of key research recommendations is given.

The mountain plover, contrary to its name, avoids shorelines and montane areas and is primarily associated with short-grass prairie that has been burned or heavily grazed (Alberta Sustainable Resource Development (SRD) 2003). Bison, pronghorn antelope and prairie dog grazing in combination with fire were historically important for maintaining suitable habitat for this species (Knopf 1996a).

The mountain plover is a regular transient visitor to Alberta, but is at the extreme northern periphery of its breeding range in southeastern Alberta (SRD 2001a). Mountain plovers are listed as "Sensitive" in Alberta due to their small population size (zero to six pairs) and narrow habitat preferences (SRD 2001a, SRD 2003). Due to the rarity of plovers anywhere in Canada, they have been designated as nationally "Endangered" since 1987 (COSWEIC 2002). The population of adult plovers in Canada has been estimated at less than 50 for the past 25 years (Wershler 2000). Few historical accounts are available that provide an accurate indication of what the pre-settlement mountain plover population may have been in Canada (SRD 2003). The current North American population of mountain plovers is estimated to range from 8,000 to 10,000 birds (Wershler 2000). The continental population of plovers is estimated to have declined by 63 percent between 1966 and 1991 (Knopf and Rupert 1996). Consequently, mountain plovers were listed as a "proposed threatened" species in the United States in 1999 (U. S. Fish and Wildlife Service 1999).

Present range management practices that discourage heavily grazed grassland are thought to restrict suitable breeding habitat for plovers in Canada (Wershler 2000). There are only two known breeding sites of mountain plovers in Alberta, the Lost River and Wildhorse sites, located in the extreme southeastern portion of the province within the Milk River Basin (Wershler and Wallis 2002, SRD 2003). Mountain plovers have nested only erratically at these sites and have not established a stable breeding population in the province (Wershler 2000, SRD 2003). Breeding was first confirmed in Alberta in 1979 (Wershler 2000). Breeding has only been recorded in one other location in Canada, in the extreme southwestern corner of Saskatchewan, near Val Marie (SRD 2003). The closest stable breeding population of mountain plovers from Alberta is found in northern Montana, approximately 140 km away (Wershler 2000). A second, core breeding population of plovers is found in Colorado. Collectively, Colorado and Montana are thought to support the majority of the global breeding population of this species (SRD 2003). The mountain plover's breeding range also includes the tablelands of Wyoming, New Mexico, and small portions of western Kansas and Oklahoma, and the Texas panhandle (Knopf 1996a). Plovers overwinter primarily in California and in parts of northern Mexico, southern Arizona and southern Texas (Wershler 2000).

The significant range-wide decline of mountain plovers in recent decades is thought to have occurred due to a combination of factors: the conversion of vast tracts of native prairie to cropland; habitat loss due to urban and industrial development; current agricultural and range management practices; removal or population reduction of key herbivores such as bison (*Bison bison*), prairie dogs (*Cynomys* spp.) and pronghorn antelope (*Antilocapra* a*mericana*); and the suppression of natural fire regimes (Knopf 1996a, Wershler 2000, SRD 2003). Small, isolated breeding populations of plovers in Alberta are also vulnerable to natural events such as weather extremes (*i.e.,* drought or flooding) as well as predation (Wershler 2000).

Two draft Alberta management strategies and a National Recovery Plan have been prepared for mountain plovers (Wershler 1990, 1991, Edwards *et al.* 1993). However, despite these plans, there has been no direct management of this species in Alberta (Wershler 2000, SRD 2003).

1.2 Ecology

Mountain plovers are capable of breeding one year after hatching and breed annually thereafter (Graul 1973). Plovers generally arrive on the breeding grounds already paired, otherwise pairing begins immediately after arrival (Knopf 1996a). In Alberta, plovers arrive on the breeding grounds in April and commence breeding in early to mid-May (Wershler 2000). Nesting usually occurs from May to July (Wershler 2000). Mountain plovers display a high degree of breeding site fidelity, usually returning to the same general area to nest (Knopf 1996a, Ellison Manning and White 2001). Returning to an area that is familiar to an individual may improve success in obtaining mates, territory and food (Ellison Manning and White 2001). Plovers will seek out new nesting areas if previously used nesting sites are unsuitable (Wershler 2000).

Male plovers construct small nest scrape depressions on the ground, approximately 9 cm to 10 cm in diameter and approximately 2.5 cm deep (Knopf 1996a). Grass roots, leaves, dried cow manure chips, and bits of lichen are often used as nesting material to cover the eggs during incubation (Graul 1975, Knopf 1996a). A typical plover clutch contains 3 eggs (Graul 1975, Knopf 1996a). Under suitable weather conditions and abundant food, plovers may lay two clutches in succession, with the first incubated by the male, and the second by the female (Knopf 1996a, Wershler 2000). Eggs are usually laid 34 to 48 hours apart (Knopf 1996a). Incubation begins once the last egg has been laid (Knopf 1996a). The incubation period is typically 29 days in duration, but can last from 28 to31 days (Graul 1975, Knopft 1996).

Mountain plover chicks fledge once they reach 70% of adult body weight, usually 33 to 34 days after hatching (Graul 1975, Miller and Knopf 1993, Knopf 1996a). Adults and fledged chicks usually leave the breeding grounds between late July or mid-August (Knopf 1996a). Most birds arrive at wintering grounds by early November where they gather in small localized flocks (Knopf 1996a).

1.2.1 Diet

Mountain plovers are opportunistic foragers and display a high degree of dietary flexibility across their range (Knopf 1996a). Winged invertebrates and ground dwelling invertebrates are the main food sources for this species (Knopf 1996a). Baldwin (1971) conducted a dry-weight biomass study from the stomachs of 13 mountain plovers in Colorado. Baldwin (1971) reported that 99.7% of the plover diet consisted of invertebrates and the remaining 0.3% was comprised of seeds. The invertebrates consumed represented 90 different taxa; beetles (Coleoptera; 60%), grasshoppers and crickets (Orthoptera; 24.5%), and ants (Hymenoptera: 6.6%) were the most important prey items (Baldwin 1971).

1.2.2 Predators

Mountain plover eggs and chicks are vulnerable to predation from thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*), swift fox (*Vulpes velox*), badger (*Taxidea taxus*), and coyote (*Canis latrans*) (Knopf 1996a). Common avian predators include Swainson's hawk (*Buteo swainsonii*), prairie falcon (*Falco mexicanus*), loggerhead shrike (*Lanius ludovicianus*), ring-billed gull (*Larus delawarensis*), and black-billed magpie (*Pica pica*) (Miller and Knopf 1993, Knopf and Rupert 1996).

Mountain plovers have developed a number of adaptations to reduce predation including: cryptic plumage colouration; multiple clutches; predator distraction displays by adults; shell removal from the nest at hatching; and rapid movement of chicks from the nest after hatching (Graul 1975, SRD 2003). Despite these adaptations, predation typically has a significant impact on reducing plover nest and fledging success (Graul 1975, Miller and Knopf 1993, Knopf 1996a). Often, greater than 50 percent of clutches are lost to predators (Miller and Knopf 1993, Knopf 1996a).

1.3 Habitat Requirements

1.3.1 General

The mountain plover is considered a "habitat specialist", occupying areas of open, flat grassland expanses with short, sparse vegetation and high amounts of bare ground (Knopf and Miller 1994, Knopf 1996a, Dechant *et al.* 2003, SRD 2003). Heavily grazed areas, or areas disturbed by fire or prairie dogs are considered highly suitable plover habitat (Knopf and Miller 1994, Knowles *et al.* 1982, Knowles and Knowles 1984).

In Alberta, mountain plovers are restricted to the Dry Mixedgrass Subregion of the Grassland Natural Region (SRD 2003).

1.3.2 Nesting Habitat

Mountain plover nesting sites typically have short vegetation (less than 10 cm in height), extensive amounts of bare ground or lichen cover (between 30 to 50 percent) and occur in extensive areas (0.5 to 1 km in diameter) of flat terrain (less than 5 percent slope) (Graul 1975, Olson and Edge 1985, Knopf 1996a, Dechant *et al.* 2003, SRD 2003). Nesting sites are typically found in heavily grazed or recently burned areas (SRD 2003). Cow manure piles are often present near nests and may play a role in concealing nests from predators (Graul 1975, Knopf 1996a).

Mountain plover breeding sites in Canada were found in remnant blocks of mixedgrass prairie, the Sage Creek – Milk River Canyon – Southwest Pasture Complex in Alberta and Grassland National Park in Saskatchewan (Wershler 2000). Two basic types of breeding habitats have been documented in Alberta at the Lost River and Wildhorse sites (Wershler 2000). Breeding habitat at the Lost River area consisted of extensive, open grassland (with no or a few scattered sagebrush) on sandy loam soils formed over outwash materials (Wershler 2000). Habitat at the Wildhorse breeding site was characterized by discontinuous, open grassland within grassland-sagebrush or lower-lying Solonetzic "blow-out" vegetation (Wershler 2000). Dominant plant species found at nest sites at the Lost River site included sedge (*Carex filifolia*), sandberg bluegrass (*Poa sandbergii or P. secunda*), June grass (*Koeleria macrantha*), and blue grama (*Bouteloua gracilis)* (Wershler and Wallis 1986). Bare ground ranged from 15% to 25% on unburned breeding sites to 45% to 50% on recently burned breeding sites in Alberta (Wershler and Wallis 1986).

In several areas of its range, including Grasslands National Park, Saskatchewan, mountain plover breeding sites are located within active black-tailed prairie dog (*Cynomys ludovicianus*) towns (Knowles and Knowles 1984, Knowles *et al.* 1982, Olson and Edge 1985, Olson-Edge and Edge 1987, Wershler 2000). Plover nests in Utah are associated with white-tailed prairie dogs (*Cynomys leucurus*) (Ellison Manning and White 2001). Prairie dog towns are used for breeding, rearing of young, feeding and roosting (Knowles *et al.* 1982, Olson and Edge 1985). Prairie dogs provide areas of short vegetation or bare ground as a result of their grazing and mound construction. Horizontal visibility and bare ground is significantly greater inside towns, while grass cover and total plant cover is significantly less than in adjacent areas (Knowles *et al.*1982). Several characteristics were common amongst prairie dog towns occupied by mountain plovers in Montana: all towns were active; vegetation was short; they were on upland level areas; they were moderately to heavily grazed by cattle on a four-year, rest-rotation grazing system; and they were at least 6 ha in size (Olson-Edge and Edge 1987). Within towns, plovers nested near small clumps of forbs or fringed sagewort (*Artemisia frigida*) (Olson and Edge 1985). It is believed that cattle grazing contributes to prairie dog habitat, which in turn contributes to mountain plover habitat (Fagerstone and Ramey 1996). It has been contended that in Montana, cattle grazing alone results in the persistence of shrubs and woody forbs, and that it is only in conjunction with prairie dogs that suitable mountain plover habitat is created (Knowles *et al.* 1982, Olson and Edge 1985). Due to their perceived threat as a competitor with domestic livestock and designation as a "pest" species, prairie dogs have been eradicated from the majority of their historical range in North America (Fagerstone and Ramey 1996). Prairie dogs likely inhabited the Milk River Basin at one time, but their current range in Canada is restricted to the extreme southwestern portion of Saskatchewan. The Richardson's ground squirrel, a common burrowing mammal within the plover range in Alberta, is considered ecologically similar to prairie dogs; however, the role of ground squirrels in maintaining or creating suitable mountain plover habitat needs to be further investigated (Wershler 2000).

Mountain plovers are also known to use fallow or recently plowed fields for nesting in the southern part of its North American range (Knopf 1996a, Shackford *et al.* 1999). However, most nests in cultivated fields are destroyed if fields are seeded in May (Knopf 1996a, Shackford *et al.* 1999). Shackford *et al.* (1999) reported that of 46 nests found on cultivated fields, 70.9% were destroyed by farm machinery. Cultivated fields are therefore regarded as a reproductive "sink" rather than "source" habitat, where mortality exceeds reproduction (Shackford *et al.* 1999).

1.3.3 Brood Rearing Habitat

As described above, mountain plovers in Montana typically stay in or adjacent to prairie dog colonies during the brood rearing period (Olson-Edge and Edge 1987). In Colorado, plover broods were noted to use areas with taller forbs or man-made structures such as fence posts for shade (Graul 1975). Most broods moved away from nest sites within the first three days after hatching, and typically remained within 300 m of the nest until they fledged (Graul 1975). In Utah, plover broods used moderately dense, low growing (less than 30 cm) shrubby areas with an open understory (Day 1994).

Chicks are especially vulnerable to predators during the 33 day to 34 day pre-fledging period (Sordahl 1991). Older, bigger chicks are more likely to run, whereas younger, smaller chicks are more inclined to hide from predators (Sordahl 1991). Chicks are more likely to run in areas of sparse vegetation, and hide in areas with more cover (Sordahl 1991).

1.3.4 Foraging Habitat

Mountain plovers forage most often within the boundaries of their territory during the breeding season, occasionally foraging in other suitable areas (Graul 1973, Knopf 1996a). Characteristic plover foraging habitat consists of extensive areas of disturbed ground with short, sparse vegetation (less than 2 cm) and interspersed patches of bare ground (Knopf 1996a). Prairie dog towns, heavily grazed or trampled areas, unpaved roads, and recently ploughed or fallow fields are examples of disturbed areas used for foraging (Knopf 1996a). Olson (1985) found a higher abundance of insect prey in areas with very short, sparse vegetation within prairie dog towns than in adjacent habitats.

Mountain plovers use a flush-pursuit method of foraging insects, suited to open areas with short vegetation (Knopf 1996a). Plovers run short distances (of approximately1 m), then pause and survey for moving insects (Knopf 1996a).

1.3.5 Area Requirements

Territories of three male plovers in Colorado were approximately 16 ha, although overlap did occur (Knopf 1996a). A minimum spacing of 100 m between plover nests was recorded in Wyoming (Parrish *et al.* 1993). Plover nests in Wyoming were placed in 20 m to 120 m patches of suitable habitat, with the majority of nests found in 20 m to 60 m diameter patches (Parrish *et al.* 1993).

Knopf and Rupert (1996) estimated that the minimum area required for brood rearing by mountain plovers was at least 28 ha for plovers in Colorado. Plovers with broods moved an average of 300 m per day, and on average ranged over an area of 56 ha (Knopf and Rupert 1996). Two to three broods can occur in the same general vicinity, therefore plovers can raise chicks in broadly overlapping areas (Knopf 1996a). Mountain plover densities ranged from 2.0 birds / km^2 to 4.7 birds / km^2 in Colorado and from 6.8 birds / km^2 to 5.83 birds / km^2 in Montana (Knopf 1996a). In Montana, Knowles and Knowles (1998) (cited in Wershler 2000) suggested that the persistence of a mountain plover population depends on the availability of a number of suitable sites, widely spaced over a minimum area of approximately 25 km^2.

Olson-Edge and Edge (1987) suggest that prairie dog towns between 10 ha to 50 ha offer productive mountain plover habitat. Smaller prairie dog towns of 6 ha to 50 ha had higher plover densities than larger towns of 100 ha to 300 ha (Olson-Edge and Edge 1987).

1.4 Mountain Plover Response to Grazing

Bison, pronghorn and prairie dogs were the primary herbivores of the Great Plains prior to human settlement (Knopf 1996b). Bison and pronghorn preferentially graze on prairie dog towns, intensifying local grazing and trampling pressure at these sites (Coppock *et al.* 1983, Krueger 1986). Yet it is at these sites, where grazing pressure is intense and surface disturbance is excessive, that mountain plovers flourish (Knopf 1996b). Bison have since been extirpated from their former range across the Great Plains, while prairie dog numbers have been reduced by 98 percent throughout the western Great Plains (Knopf 1996b). Similarly, pronghorn populations have been greatly reduced across much of their range in comparison to their estimated pre-settlement abundance (Yoakum *et al.* 1996).

Domestic livestock have replaced bison grazers as the dominant herbivore on the prairie landscape. Strategically managed, cattle grazing can be used to create the habitat conditions required by mountain plovers (Dechant *et al.* 2003). However, maintaining habitat for plovers presents a challenge as extensive heavily grazed areas are not typically favoured for either long-term sustainable livestock production, maintained range condition, or as habitat for many wildlife species (Wershler 2000). In the same way that eliminating grazing has negative consequences for mountain plovers, conventional range management practices that encourage uniform cover and discourage heavy grazing can diminish habitat opportunities for plovers (U.S. Fish and Wildlife Service 1999, Wershler 2000). As described by Wershler (2000), in conventional range management, “the extreme of heavy grazing is usually avoided or represented in small, localized areas in the overall habitat” (Wershler 2000, p.25). Range management practices such as planting tall, dense exotic grass species (*e.g.,* crested wheatgrass (*Agropyron pectiniforme*) smooth brome (*Bromus inermis*) or timothy (*Phleum pratense*), fire suppression, or irrigation projects may also have negative implications for mountain plovers (U.S. Fish and Wildlife Service 1999). Other effects such as incidental cattle trampling destroying plover nests are considered rare and are likely comparable to historical bison trampling (Knopf 1996a).

Grazing will promote suitable breeding habitat for plovers if it removes the previous season’s plant litter by the beginning of the breeding season (Wershler and Wallis 2002); maintains patches (minimum 20 m to 60 m) of short (2 cm to 10 cm) and sparse vegetation and approximately 30 percent bare ground (Parrish *et al.* 1993); and retains scattered patches of taller vegetation to provide shelter for chicks (Graul 1975, Sordahl 1991). Grazing patterns that mimic the heterogeneity that likely existed under a dynamic bison grazing regime will most likely benefit mountain plovers (Wallis and Wershler 1981). Bison are known to have heavily grazed areas before moving on to exploit other areas as forage resources became depleted (Wuerthner 1998). Areas that were heavily grazed likely received periodic rest due to the transient nature of bison and bison population fluctuations due to climatic conditions and other natural factors (Wuerthner 1998). A constantly "shifting mosaic of grazing pressure" is thought to have resulted from the temporal and spatial variability of bison grazing (Wuerthner 1998, p.379).

Wershler and Wallis (2002) recommend intensive winter or early spring grazing to create or maintain habitat for mountain plovers in Alberta. This type of grazing program is recommended for traditional breeding areas and in surrounding high potential habitats. According to Wershler and Wallis (2002), the majority of mountain plover nesting areas in Alberta have been either winter or spring-grazed. Locally prescribed heavy summer grazing has also been suggested to promote habitat for plovers in Alberta (Wallis and Wershler 1981). In Colorado, shortgrass pastures that were heavily grazed in the summer were used by plovers for foraging and nesting (Giezentanner 1970, cited in Dechant *et al.* 2003).

From a livestock productivity standpoint, intensive winter and early spring grazing may not be well suited to maintaining cattle weight-gains or for sustained range condition of dry mixedgrass or mixedgrass prairies. Crude protein and phosphorus levels are highest in actively growing forages and decline substantially as plants become dormant (Holechek *et al.* 2003). Therefore, supplemental feeding is usually required to sustain livestock that are winter grazed in mixedgrass and dry mixedgrass prairies. Supplemental feeding practices create problems in terms of spread of exotic grasses in plover habitats (Wershler 1991, Wershler 2000). Similarly, grazing early in the spring, prior to green-up, is not recommended due to lower nutritional quality of forage at this stage. Early spring grazing is also not considered sustainable if energy reserves of plants are depleted as new growth is initiated (Holechek *et al.* 2003).

Light to moderate grazing intensity may be appropriate for maintaining plover habitat in areas with naturally sparse, low vegetation cover, during years of severe drought, or in areas with extensive burrowing mammal activity (*e.g.,* prairie dogs or Richardson's ground squirrels) (Wershler and Wallis 2002). Lower grazing intensities would also be appropriate where prescribed burning is conducted in plover habitats (Wershler 2000).

Few studies have assessed the importance of pronghorn herbivory or Richardson's ground squirrel activity in addition to livestock grazing for maintaining mountain plover habitat in Alberta (Wershler 2000). The combined effect of cattle grazing in combination with pronghorn browsing and ground squirrel activity may be important for reducing silver sagebrush encroachment and maintaining patches of bare ground for plovers. In Montana, all prairie dog towns used by plovers were also grazed by cattle, while stock pond sites without prairie dogs were not used by plovers (Knowles *et al.* 1982).

1.5 Grazing Systems and Mountain Plover Habitat Management

Table III-5 provides an overview of four pertinent grazing systems and their potential positive and negative implications to mountain plovers and their habitat. A grazing system is a tool used to control the spatial distribution, timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003). Applied research is needed to properly assess the effects of various grazing systems on mountain plovers in the Milk River Basin.

Table III-5 Grazing Systems and Mountain Plover Habitat Management

Grazing System	Discussion
Continuous (Season-Long) Grazing	
Advantages:	Season-long grazing at moderate to heavy stocking rates may create suitable conditions for mountain plovers by creating repeatedly grazed patches with short vegetation and higher amounts of bare ground (Willms pers. comm.). Strategic placement of salt and water can be used to stimulate heavy grazing near to traditional plover breeding habitats. Shifting the placement of salt and water over time can allow for periodic recovery of previously heavily used areas. Heavily grazed areas also stimulates habitat for Richardson's ground squirrels which help to perpetuate patches of bare ground and reduced vegetation height and cover (Fagerstone and Ramey 1996, Wershler 2000). In comparison to rough fescue prairie, mixedgrass and dry mixedgrass prairie communities are typically more resistant to grazing during the growing season; mixedgrass and dry mixed grass prairies fall within the suspected prehistoric bison summer range (Morgan 1980). Repeated defoliation at a moderate utilization level throughout the growing season has been found not to negatively impact species composition in mixedgrass communities (Biondini *et al.* 1998).
Disadvantages:	Season-long grazing at heavy stocking rates may not be sustainable on a long-term basis in terms of cattle weight gains, vegetation production, range condition and topsoil conservation. If cattle are consistently grazed at heavy stocking rates under season-long grazing, vegetation heterogeneity will decrease over time, leading to uniform conditions with few tall vegetation patches to provide shelter for plover chicks during the brood rearing season.
Complementary Grazing	
Advantages:	If seeded pasture is available within the grazing operation it can be used to defer early season use on native prairie, allowing for recovery of areas that were previously heavily grazed late in the season. Intensive grazing in seeded pastures may support habitat conditions required by mountain plovers, although more research is required to assess this option.
Disadvantages:	Unless breeding areas are heavily grazed late in the previous season, delaying early season grazing of these sites may not maintain suitably short vegetation that is required for nesting. Planting seeded pastures near to traditional breeding areas may result in encroachment of tall exotic graminoids into plover habitats.

Grazing System	**Discussion**
Rotational Grazing	
Advantages:	Olson and Edge (1985) reported that mountain plovers nested consistently on upland prairie dog towns that were all moderate to heavily grazed by cattle under a four pasture rest-rotation grazing system. A three-field rotational grazing system can be strategically managed to provide consecutive early and late season heavier use in at least one field each year. Fields that receive consecutive early and late season use will have short vegetation and low litter cover during the nesting season. Twice-over grazing (*i.e.,* two rotations through the grazed fields in one season) may be appropriate in a two field switch-back grazing system whereby one field is grazed once early in the season and then again late in the season. This would allow the second field to be rested during the early and late seasons every second year. Given appropriate stocking rates, suitable nesting habitat is likely to be created in the field that receives twice-over use. By allowing for periodic rest, rotational grazing systems can facilitate range recovery and sustained livestock yields. As rotational grazing systems encourage overall better utilization of fields, this may encourage, large areas of suitable habitat for plovers. Based on research in Colorado, Knopf and Rupert (1996) estimated plovers require at least 28 ha of suitable habitat for successfully raising broods. Suitable foraging habitat for plovers is comprised of extensive areas of short vegetation with interspersed bare ground (Knopf 1996a).
Disadvantages:	As prairie dogs do not occur within the Milk River Basin in Alberta, it is unclear how effective a four pasture rest-rotation grazing system would be for maintaining mountain plover habitat. In the absence of prairie dogs, fields that receive a full season of rest may not maintain suitable nesting conditions for plovers.
Intensive Grazing	
Advantages:	As mountain plover nest sites are primarily associated with heavily grazed habitats, large areas of intensive grazing is recommended for maintaining habitat for this species (Knowles *et al.* 1982, Knopf 1996a, Wershler 2000, Dechant *et al.* 2003). Wershler and Wallis (2002) recommend intensive winter or spring grazing in traditional breeding areas and in surrounding high potential habitats. Heavy grazing over large areas may also promote conditions that are suitable for Richardson's ground squirrels, an important prey species for numerous other wildlife. Richardson's ground squirrels may also help to perpetuate suitable habitat for mountain plovers (Wershler 2000).
Disadvantages:	Intensive, heavy grazing may have negative long-term consequences for livestock and rangeland productivity if it leads to a significant decline in range condition. Intensive grazing over large areas can negatively affect habitat for other wildlife species that require greater amounts of cover for nesting, shelter or foraging. Intensive grazing usually results in rapid deterioration of riparian areas in particular, with potential negative consequences for numerous wildlife species that rely on these areas (Fitch and Adams 1998).

1.6 Beneficial Management Practice Recommendations

Although there is a low possibility that mountain plovers will establish a self-sustaining population in Alberta, maintaining small, northern breeding populations contributes to the overall diversity of the species, particularly since adjoining populations in northern Montana have been extirpated (Wershler 2000). Protecting plover habitat may also afford protection to several other rare fauna and flora that occur within the plover range in Alberta (Wershler 2000).

As mountain plovers repeatedly use the same areas for breeding, management efforts should focus on protecting and maintaining suitable habitat at traditional breeding grounds in the Lost River and Wildhorse areas (SRD 2003). Surrounding areas with high potential habitat should also be appropriately managed to enhance breeding opportunities for plovers (Wershler 2000). Critical for mountain plovers is the ongoing maintenance of extensive tracts of dry mixedgrass or mixedgrass prairie with substantial areas of short grass (2 cm to 10 cm), few shrubs and interspersed patches of bare ground (Wallis and Wershler 1981). Controlled grazing or prescribed burning is necessary for maintaining these habitat characteristics.

The following list describes various land use and grazing management practices that may assist in retaining or enhancing suitable habitat for plovers as well as minimizing human-caused mortality.

1.6.1 General Recommendations

- Protect the known Lost River and Wildhorse mountain plover breeding sites in Alberta from industrial development or fragmentation by linear disturbances (*e.g.,* road construction) (Wershler 1991, U.S. Fish and Wildlife Service 1999, Wershler 2000). Protecting traditional breeding sites is important as mountain plovers usually return to the same sites to breed year after year (Knopf 1996a).
- Within known mountain plover breeding areas, protect remaining dry mixedgrass and mixedgrass native prairie from cultivation. In the Lost River area, an estimated 2 to 3 square miles of potential habitat was planted to exotic forage crops (Wershler 1991). Plover nests, eggs, and chicks in cultivated fields are at risk of being destroyed by farm machinery if planting occurs during the nesting period (May to June) (SRD 2003).
- Consider planting winter wheat in areas where croplands exist within the vicinity of known mountain plover breeding areas (Shackford *et al.* 1999). Winter wheat fields require less disturbance in spring and early summer and may permit plovers to successfully breed on cultivated fields (Schackford *et al.* 1999). Winter wheat is usually seeded into standing stubble in late August or early September, and harvested early the following August (Fowler 2002).
- Avoid plowing during the nesting season in cultivated fields that may be used for breeding by mountain plovers (Knopf 1996a).
- Avoid developing irrigation systems on “marginal land” within suitable plover habitats.

- Maintain grazing as a disturbance process within known plover breeding habitats at the Lost River and Wild Horse sites. Mountain plovers prefer nesting in heavily grazed areas (See Grazing Recommendations, below).
- Consider the use of prescribed burning at known breeding sites to maintain suitable mountain plover habitat, particularly in areas where grazing disturbance has been removed (Wershler 1991, Knopf 1996a, Dechant *et al.* 2003). Prescribed burning can be used to create and maintain areas of shorter grass within mixedgrass prairie (Dechant *et al.* 2003). Burns should be carefully conducted in late summer or early fall (during appropriate conditions) to promote suitable habitat for the next breeding season (Wershler 1991, Dechant *et al.* 2003). The major plant species in plover nesting habitats are most fire-resistant during late summer or early fall, and this is also the season when natural lightning strike fires occur in the region (Wershler 1991). Prescribed burns should only be conducted under the supervision of experienced professionals.
- Maintain populations of burrowing small mammals such as Richardson's ground squirrels that may serve a similar ecological function as black-tailed prairie dogs (SRD 2003). Ground squirrels maintain areas with short vegetation and their burrowing activities increase bare soil cover. Discontinue Richardson's ground squirrel control on Crown lands in the Lost River region (Wershler 1991). Promote natural predators as biological rodent control agents.
- Promote dual use of mountain plover habitats by pronghorn antelope by ensuring that barbed wire fences allow for pronghorn passage under the bottom wire (Yoakum *et al.* 1996). A smooth bottom wire raised at least 41 cm from the ground is suggested on rangeland occupied by cattle and pronghorn (Yoakum *et al.* 1996).
- Investigate methods to reduce shrub encroachment in mountain plover breeding habitats where shrub growth exceeds desired thresholds for suitable nesting habitat.
- Minimize the spread of exotic plants in mountain plover habitats (Wershler 1991, Dechant *et al.* 2003). Tall exotic grasses such as smooth brome (*Bromus inermis*) or timothy (*Phleum pratense*) are not adapted to tolerate intense grazing and their dense, tall growth habit does not create suitable habitat for mountain plovers (SRD 2003). Reclaim pipeline rights-of-way or roadside ditches using native species or allow for natural recovery, where appropriate.
- Avoid the use of pesticides, such as spraying for grasshoppers, in the vicinity of suitable mountain plover breeding habitats (Wershler 2000, SRD 2003). Although more research is needed to assess the effects of pesticides on mountain plover survival or reproductive success, plovers are susceptible to exposure to pesticide residue as they are primarily insectivorous. Preliminary studies have found that levels of DDE and selenium may be harmful to plovers (U.S. Fish and Wildlife Service 1999). The use of pesticides may also result in diminished prey availability which may affect mountain plover productivity (U.S. Fish and Wildlife Service 1999).
- Restrict industrial or recreational activities (such as off-road vehicle use) near mountain plover breeding sites during the peak breeding season (May to July) (Dechant *et al.* 2003). Development activity near plover nesting areas increases their susceptibility to vehicle mortality and fragments areas of suitable habitat. Presently there are no formal industrial development timing restrictions or set-back distances recommended for mountain plovers in Alberta (SRD 2001b).

- Conduct pre-development wildlife surveys in known or potential mountain plover breeding sites to locate mountain plover nests, and re-route planned developments where necessary.
- Limit vehicular traffic through mountain plover breeding habitats during the breeding season (Wershler 2000). Mountain plovers often nest or feed near roads or use them as travel corridors and may be killed or injured by vehicles (U.S. Fish and Wildlife Service 1999, Wershler 2000).
- Restrict direct human disturbance near mountain plover nest sites during the breeding season (U.S. Fish and Wildlife Service 1999). Adult plovers have been known to abandon eggs after being disturbed on the nest; stress-related mortality has also been reported among adults (Graul 1975). Human activity can also lead to intolerable levels of exposure of chicks to natural elements (*e.g.,* temperature extremes) (U.S. Fish and Wildlife Service 1999). Graul (1975) found that mountain plover chicks less than 2 weeks old died from heat exposure within 15 minutes without shade when temperatures exceeded 27 degrees Celsius (Graul 1975).
- Develop a public awareness campaign for landowners, stakeholders and visitors to the Lost River and Wildhorse areas (Wershler 1991). Brochures, posters, or information signposts can be used to inform the public about mountain plovers and their habitat requirements. Public awareness campaigns are important for promoting voluntary participation in population monitoring programs and promoting adoption of beneficial management practices.

1.6.2 Grazing Recommendations

Maintaining grazing disturbance is important for continued provision of suitable habitat for mountain plovers (Knopf 1996a, Wershler 2000, Dechant *et al.* 2003). As the extremely heavily grazed conditions favoured by mountain plovers are not appropriate for many other wildlife species, controlled or strategic grazing should be used to selectively manage for plover habitat rather than promoting extensive heavy grazing in the region (Payne and Bryant 1994). A range management program for mountain plovers should be restricted to the Lost River and Wildhorse traditional breeding areas and in key areas of surrounding high potential habitat (Wershler and Wallis 2002). Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

Grazing management geared toward mountain plovers should aim to perform the following functions:

- Maintain sufficient patches of short grass and bare ground for foraging and nesting (Knopf 1996a);
- Remove previous season's litter build up prior to the start of the next breeding season (Wershler and Wallis 2002);
- Control the spread of tall, exotic grasses in plover nesting areas (Wershler 1991);
- Promote insect species abundance and diversity; and
- Promote habitat for burrowing small mammals that are ecologically similar to prairie dogs (Wershler 1991, Wershler 2000).

To perform these functions, the following grazing or range management principles should be applied:

- Create and maintain large (minimum 20 m to 60 m diameter) patches of heavily grazed vegetation (2 cm to 10 cm) and approximately 30 percent bare ground in known mountain plover breeding areas (Parrish *et al.* 1993, Knopf 1996a).
- A 50% proper utilization factor is typically recommended for mixedgrass and dry mixedgrass prairie (Adams *et al.* 1994). This degree of utilization may not be appropriate for maintaining mountain plover habitat. Increased utilization may be warranted based on local environmental conditions and an initial assessment of the effectiveness of distribution tactics or timing of grazing to create suitable conditions for mountain plovers.
- Avoid uniform grazing of grasslands (Wallis and Wershler 1981).
- Apply controlled, late-season or early-season heavy grazing near to traditional plover breeding areas. This may be accomplished by either three-field rotational grazing whereby at least one field receives consecutive early and late season use; or by a two field system using twice-over grazing (where a field is grazed twice during one season).
- Season-long grazing at a suitable stocking rate may be appropriate for meeting mountain plover habitat needs if sufficiently large patches of heavy use are perpetuated (Willms pers. comm.)
- Strategically distribute salt and water to encourage heavier use near preferred nesting areas (Wershler 2000).
- Vary intensity and frequency of use in plover breeding areas in accordance with fluctuations in precipitation and local environmental conditions– *i.e.,* less use may be required during drought years or in areas with naturally sparse vegetation, while twice-over late-season grazing may be necessary in years of higher precipitation or in more productive range sites.
- Reduce grazing intensity in plover habitat in recently burned areas (Wershler 2000).
- Retain some patches of taller vegetation in brood rearing areas (a 28 ha area around nest sites (Knopf and Rupert 1996)) to provide shade and predator escape shelter for chicks (Graul 1975, Sordahl 1991).
- Control the spread of exotic invasive graminoids in mountain plover nesting habitat due to supplemental feeding practices. Avoid placing feeding stations near to existing or high potential nesting areas. Where possible, limit feeding stations to existing cultivated areas or seeded pastures to avoid exotic species encroachment in native prairies (Wershler 1991).
- Avoid creating new seeded pastures near to traditional mountain plover habitats.
- Avoid creating access roads, corrals or ranch buildings within traditional mountain plover breeding areas or in surrounding high potential habitats (Wershler 2000).

1.7 Research Recommendations

Applied research is warranted to better assess management practices that will maintain suitable mountain plover habitat in the Milk River Basin. Ongoing monitoring of plover populations in Alberta is important to assess population trends and response to habitat management initiatives (SRD 2003).

Key research needs for the mountain plover are listed below.

- Conduct consistent annual surveys of mountain plovers in high potential habitats and in traditional breeding areas in the Milk River Basin (Wershler and Wallis 2002, SRD 2003). Surveys should be conducted in mid-April to early May when birds are returning from wintering grounds as well as during the nesting phase (early May to mid-June) (Wershler and Wallis 2002).
- Continue to document population sizes of nesting birds, habitat use and nesting success (Wershler and Wallis 2002).
- Collect additional information on plover habitat use before and after the breeding season (Wershler 1991).
- Evaluate the effectiveness of different livestock grazing practices (*i.e.,* grazing intensity, grazing system, and timing of grazing) for creating or maintaining suitable mountain plover habitat (Knopf 1996a). Conduct grazing research in potential nesting habitats adjacent to traditional breeding sites (Wershler 1991). Attempt to determine which grazing strategies and stocking rates are best suited for maintaining sufficient habitat for mountain plovers while also supporting sustained livestock and rangeland productivity. This type of research program should build on studies that are on-going at the OneFour Research Sub-station near Manyberries, Alberta to evaluate the impact of fall grazing and various grazing intensities on range condition and wildlife habitat (Willms pers. comm.).
- Investigate the use of prescribed burning alone and with various combinations of grazing as a tool to create or maintain mountain plover habitat (Wershler 1991).
- Evaluate mountain plover nesting success in relation to various management techniques (*e.g..,* grazing and or prescribed burning) and habitat characteristics (*e.g.,* vegetation structure, plant species composition and amount of bare ground).
- Investigate the contribution of pronghorn herbivory in combination with cattle grazing for maintaining suitable mountain plover habitat.
- Investigate the importance of Richardson's ground squirrels for maintaining suitable breeding habitats for mountain plovers at the Lost River and Wildhorse sites (Wershler 2000).
- Investigate appropriate setback distances for high and low impact human activities from mountain plover nest sites in the Milk River Basin (Wershler 2000, SRD 2001b).

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D. BURROWING OWL

1 INTRODUCTION

1.1 Background

The purpose of this report is to summarize the ecology and habitat requirements of the burrowing owl (*Athene cunicularia*) in southern Alberta. Based on this information and supporting scientific studies, various grazing systems are compared in terms of their potential implications to burrowing owl ecology and habitat. This discussion is followed by a summary of recommended beneficial management practices to enhance burrowing owl habitat in the Milk River Basin in Alberta, with broader application to the range of this species within the Grassland Natural Region of Alberta (Alberta Environmental Protection 1994). Lastly, a brief summary of additional information needs that would improve our understanding of burrowing owl ecology, habitat needs and response to land management is presented.

The burrowing owl is listed as "At Risk" of extirpation in Alberta and is designated as "Threatened" under Alberta's *Wildlife Act* (Alberta Sustainable Resource Development (SRD) 2001a). The 1995 burrowing owl population in Alberta was estimated at 700 to 900 breeding pairs and declining (SRD 2001a). Agricultural destruction of native prairie habitat, intensified land use, pesticide use, eradication efforts to control burrowing rodents and an increase in prairie predator populations are contributing factors to the continuing population decline of this species (Hjertaas *et al.* 1995, Dechant *et al*. 2001).

1.2 Ecology

Burrowing owls overwinter in Mexico and Texas and typically return to their breeding grounds in Alberta between early April and early May (Wellicome 1997). Arrival dates vary with the severity of spring weather conditions (Wellicome 1997). Egg laying begins between late April and late May in Alberta, with eggs incubated for approximately four weeks (Hjertaas *et al*. 1995, Wellicome 1997). Clutch sizes range from six to eleven eggs (Wellicome 1997). Hatchlings are altricial and rely on being fed by their parents during their first few weeks of development. Chicks become fully independent at 60 to 70 days old (Wellicome 1997). Burrowing owl nests are usually lined with dried, shredded cow or horse manure, possibly to mask nest odours to avoid predation (Wellicome 1997, Dechant *et al.* 2001).

1.2.1 Diet

Burrowing owls are generalist predators and primarily consume small mammals and arthropods (Wellicome 1997, Dechant *et al.* 2001). Food intake (prey abundance) was found to be more limiting during brood rearing than during egg laying in an experimental study conducted in Saskatchewan (Wellicome *et al.* 1997). Owls that received supplemental food during the nestling stage produced 41% more fledglings than owls that were not given supplemental food (Wellicome *et al.* 1997). In Alberta, deer mice (*Peromyscus manicuatus*) and meadow voles (*Microtus pennsylvanicus*) made up as much as 90% of owl diets by weight early in the breeding season (Schmutz *et al.* 1991, Haug *et al.* 1993). In south-central Montana, the breeding season diet of burrowing owls consisted of 72% small mammals; primarily prairie voles (*Microtus ochrogaster*) and secondarily mice (*Peromyscus* spp.). In this study, insects were difficult to quantify from pellets and were likely under-represented in the sample. In Alberta, dung and carrion beetles are often consumed early in the breeding season, and in some years, grasshoppers form a significant part of owl diets later in the season, constituting up to 35% of the mass consumed (Wellicome 1997). In Saskatchewan, invertebrates comprised 93% of the prey species consumed by burrowing owls (Haug 1985).

1.2.2 Predators

Burrowing owls have numerous potential predators including striped skunks (*Mephitis mephitis*), American badgers (*Taxidea taxus taxus*), coyotes (*Canis latrans*) and various raptor species (Wellicome 1997).

1.3 Habitat Requirements

1.3.1 General

Burrowing owls are most abundant in the Mixedgrass and Dry Mixedgrass Natural Subregions of Alberta, and seldom occur in fescue grasslands (Wellicome 1997). Burrowing owls do not dig their own burrows but instead rely on burrowing mammals such as Richardson's ground squirrels (*Spermophilus richardsonii*), black-tailed prairie dogs (*Cynomys ludovicianus*), and badgers to excavate their nest sites (Dechant *et al.* 2001). In Canada, black-tailed prairie dogs only occur in and near the Frenchman River Valley in southern Saskatchewan (Environment Canada 2003). Black tailed-prairie dogs are more common in the arid short and mixedgrass prairies of the Great Plains of the United States. The largest remnant populations of this rodent are currently found in South Dakota, Wyoming, Montana and Mexico (U.S. Fish and Wildlife Service 2003). Burrows are an essential feature of burrowing owl habitat as they provide shelter from predators, protection of eggs and small young as well as shelter from adverse weather (Clayton and Schmutz 1999).

The habitat suitability index (HSI) model for burrowing owls in the Milk River Basin included four variables: native prairie coverage; soil texture; shrub-tree coverage; and distance from linear disturbance (roads) (Skiftun 2004). Native prairie cover is the most important factor in the formula and is weighted more strongly than the other variables. According to the HSI model, native prairie with moderate to moderately coarse textured soils (silty loam to sandy loam), zero percent cover of trees and shrubs and that is greater than 800 m from linear disturbance, represents ideal burrowing owl habitat.

1.3.2 Nesting Habitat

Burrowing owl nesting habitat is characterized by available nest burrows, short or sparse vegetation and open, treeless plains (Wellicome 1997). Pastures grazed by livestock provide the majority of nesting habitat for this species in Canada (Wellicome 1997). Short vegetation at nest burrows is thought to be important to allow owls to easily detect predators (Felskie pers. comm.). Clayton and Schmutz (1999) reported that burrowing owls near Hanna, Alberta preferred shorter ($\leq$ 10 cm) grasses for both nesting and roosting and that all nests sites and the majority of roost sites were in native pasture in moderately to heavily grazed areas. In Saskatchewan, the majority of burrow sites examined were found on lacustrine and secondarily solonetzic soils (Harris and Lamont 1985). Nest burrows have been found in the following soil types: loamy sand soils, silty loam soils, silty clay loams and sandy loam soils (Dechant *et al.* 2001). Silty loam soils may be more suitable than loamy sand soils for maintaining stable burrows (Dechant *et al.* 2001).

In the great plains of the United States, burrowing owls have been found to occupy both inactive and active prairie dog colonies (Desmond *et al.* 2000, Dechant *et al.* 2001). However, owls in larger, well-populated prairie dog colonies typically have higher nest success rates, lower nest predation rates and are more likely to return to their nesting sites (Desmond *et al.* 2000, Dechant *et al.* 2001). Active prairie dog colonies are thought to be preferred as prairie dogs offer an alternate prey source for predators, control the encroachment of dense vegetation and structurally maintain burrows so that they remain suitable for owls (Dechant *et al.* 2001). Although prairie dogs are not found within the Milk River Basin, Richardson's ground squirrels occupy a similar niche and are common in the area. On the Regina Plain in Saskatchewan, owls selected pastures for nesting that were more level, more likely to be grazed and that had a greater density of Richardson's ground squirrel holes (James *et al.* 1991).

Burrowing owls typically use several non-nest (satellite) burrows likely as a predator avoidance strategy (Wellicome 1997, Dechant *et al.* 2001). In central Saskatchewan, an average of six suitable burrows was available within 30 m of the nest burrow (Haug and Oliphant 1990). Habitat fragmentation concentrates owls into smaller areas of suitable nesting habitat. Increased nesting density can lead to increased intraspecific competition and potentially to higher nest abandonment and lower productivity (Dechant *et al.* 2001).

1.3.3 Foraging Habitat

Burrowing owls tend to remain near the nest burrow during daylight hours where they forage opportunistically, roost and loaf (Haug and Oliphant 1990). Prey consumed during the day is mainly insects. At night, owls travel greater distances from their nest site and hunt for small mammals (Haug and Oliphant 1990). Foraging area requirements are therefore considerably larger than nesting area requirements. The nocturnal foraging habits of burrowing owls were investigated using telemetry in an intensively farmed area south of Saskatoon, Saskatchewan (Haug and Oliphant 1990). In this study, peak foraging activity occurred between 2030 and 0639 hours, and 95% of all movements were within 600 m of the nest burrows. Haug and Oliphant (1990) noted that burrowing owls preferred to forage in grass-forb areas in uncultivated fields, ungrazed areas and roadside habitats and tended to avoid foraging in croplands and heavily grazed pastures. Similar findings were reported by Sissons *et al.* (2001) for a burrowing owl population in southern Saskatchewan which avoided croplands and fallow fields and instead preferred pastures as foraging habitat. Haug and Oliphant (1990) report that preferred foraging habitats greater than 50 m from nest burrows had dense, permanent vegetation greater than 30 cm but less than 60 cm in height (Haug and Oliphant 1990). Wellicome (1994) noted that these habitats had higher densities of deer mice and meadow voles in comparison to cropland and heavily-grazed pastures. Cropland vegetation greater than one meter may be too tall for burrowing owls to effectively forage in due to mobility considerations or prey concealment (Dechant *et al.* 2001). In addition, wheat fields in Canada have been shown to contain a low diversity of small mammals (primarily deer mice), while heavily grazed pastures have been shown to have low relative abundance of prey (Wellicome and Haug 1995). Therefore, while burrowing owls require a sparsely vegetated open area with a suitable nest burrow for nesting and brood rearing, they also require permanent cover and tall vegetation (30 cm to 60 cm) within their foraging home range to find sufficient prey (Wellicome 1997).

1.3.4 Area Requirements

Nesting area requirements for burrowing owls ranged from 0.041 km^2 to 0.073 km^2 in North Dakota (Grant 1965). The minimum foraging home-range size for six radio-tagged owls in Saskatchewan averaged 2.41 km^2 (Haug and Oliphant 1990).

1.4 Burrowing Owl Response to Grazing

The majority of burrowing owl studies purport grazing as an important factor for maintaining nesting areas. Specifically, the tendency for owls to nest in moderate to heavily grazed pastures is widely reported across their North American range (Dechant *et al.* 2001). As discussed, Clayton and Schmutz (1999) reported that owls in southeastern Alberta and Saskatchewan chose moderately to heavily grazed grasslands for nesting and roosting and avoided cultivated fields. In south-central Saskatchewan, Wedgwood (1976) noted that burrowing owls nested in heavily grazed areas within shortgrass pastures containing ground squirrel burrow or American badger excavations. Another study conducted in southern Saskatchewan reported similar results with owls shown to avoid cropland and fallow fields and prefer pastures for nesting (Sissons *et al.* 2001). In Manitoba, the cessation of grazing is thought to have degraded the suitability of historically successful breeding habitat (Uhmann *et al.* 2001). Moderate grazing is thought to be critical for maintaining consistently short ($\leq$6 cm) vegetation height at nest burrows in this province (Uhmann *et al.* 2001). In North Dakota, burrowing owls nested in moderately and heavily grazed mixedgrass pastures but not in lightly grazed pastures or mowed hayland (Kantrud 1981). Faanes and Lingle (1995) reported that preferred nest sites were in heavily grazed or mowed mixedgrass and shortgrass prairie in the Platte River Valley of Nebraska. Of note, in the arid shortgrass prairies of eastern Colorado, Montana, Wyoming and New Mexico, black-tailed prairie dogs may be able to maintain a low vegetation profile without livestock or bison grazing influences (Holechek *et al.* 2003). Whether the same can be said for Richardson's ground squirrels is a topic that requires further research.

Although grazing is recognized as important to the maintenance of suitable burrowing owl nest sites, few studies have been done to investigate which grazing strategies work best to provide sustainable nesting habitat. In addition, few studies have been done to assess the merits of various grazing strategies for maintaining not only nesting but also suitable foraging habitat and healthy populations of prey species.

1.5 Grazing Systems and Burrowing Owl Habitat Management

Table III-6 provides an overview of six pertinent grazing systems and their potential positive and negative implications to burrowing owls and their habitat. A grazing system is a tool used to control the spatial distribution, timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003). Applied research is needed to properly assess the effects of various grazing systems on burrowing owls in the Milk River Basin.

Table III-6 Grazing Systems and Burrowing Owl Habitat Management

Grazing System	Discussion
Continuous (Season-long) Grazing	
Advantages:	One of the primary benefits of a continuous grazing system is that it does not require cross fencing, and therefore does not create artificial perching sites for burrowing owl raptor predators (Felskie pers. comm.). Clayton and Schmutz (1999) reported that avian predation was responsible for the majority of post-fledgling mortalities in their study area near Hanna, Alberta. Fledgling mortality was high in this study area, estimated at 65% in 1995 and 40% in 1996. Another key benefit of continuous grazing, at moderate stocking rates, is that it promotes patchy grazing and therefore creates a more heterogeneous grassland habitat (Robertson *et al.* 1991). Under a moderate stocking rate, cattle grazing is selective and those areas near water or salt or with more palatable grasses will receive heavier use than other areas. Grazed patches will receive repeated use as these patches have a lesser build up of litter and higher cover of more palatable regrowth vegetation (Robertson *et al.*1991). As Warnock (1997) suggests, burrowing owl habitat quality can be improved by a mix of short and taller vegetation. Burrowing owls require short grass near nests for visibility and taller vegetation within 600 m of nests to provide habitat for their prey (Warnock 1997, Felskie and Scobie pers. comm.). Patchy grazing creates these conditions, with some areas receiving repeated grazing of regrowth and other areas receiving a gradation of minor to no use. Habitat patchiness not only provides structural diversity but also stimulates plant and animal diversity (Rottman and Capinera 1983, Saab *et al.* 1995, Bai *et al*.2001). This diversity promotes a more varied and likely more stable forage base for burrowing owls. Continuous grazing is better suited to dry mixedgrass and mixedgrass prairie than fescue prairie. Mixedgrass plants are in general more tolerant of heavier grazing pressure for sustained periods and earlier in the season than are fescue communities (Adams *et al* 1994). In a continuous grazing system, areas of heavier use can be controlled by the strategic placement of salt, mineral supplements or water. These techniques can be applied to maintain short vegetation near nesting sites, if warranted. However, the appropriate timing and desired intensity of cattle use near burrow sites needs further investigation. Disturbance near burrow sites is likely not desirable during nest initiation and egg laying (April to May) as it has the potential to negatively effect nest success (Scobie pers. comm.). Later season use near burrow sites can ensure that short structural conditions are present early the next season, while minimizing trampling risks to nests. Salting is likely not required near nest sites as cattle are naturally attracted to forage near burrow sites. Coppock and Detling (1986) demonstrated that bison fed selectively on moderately grazed, grassy areas near the periphery of prairie dog colonies. These areas were shown to have more readily digestible perennial grasses with higher nitrogen concentrations and accessible green tissue than areas uncolonized by prairie dogs (Coppock and Detling 1986).
Disadvantages:	At intensive stocking rates, continuous grazing can create uniform, short vegetation across the range. This type of habitat does not offer as many refugia for mammalian burrowing owl prey such as meadow voles (Wellicome 1997, Scobie pers. comm.). As reported by Haug and Oliphant (1990), heavily grazed pastures were avoided by owls during nocturnal foraging in their Saskatchewan study area. Intensive grazing not only has the potential to reduce foraging habitat quality but also increases trampling risks to nests and chicks. Continuous grazing is also potentially detrimental to riparian systems if alternate water sources are not available. Heavy persistent use of riparian corridors can diminish their quality as prey habitat for burrowing owls (Felskie pers. comm.).

Grazing System	Discussion
Deferred Grazing	
Advantages:	Deferred early-season grazing (April and May) in pastures containing active burrowing owl nests may be beneficial to preventing trampling disturbance at nest burrows during the spring. Deferred early season grazing can also be advantageous to improving the overall vigour and range health by preventing defoliation during the critical early season growing stage (Wambolt 1979). Improved rangeland health has numerous benefits to rangeland fauna and flora (Adams *et al.* 2003).
Disadvantages:	If the period of deferral extends into June or July, spring regrowth of vegetation may diminish the quality of burrowing owl nesting grounds by reducing visibility.
Complementary Grazing	
Advantages:	Complementary grazing is a form of season-of-use grazing, with seeded pasture grazed earlier or later in the season than native mixedgrass prairie. Complementary grazing, like deferred grazing, can be used to reduce disturbance to owls during breeding, nest initiation and egg laying. Seeded pasture is well suited for early season use and can maintain its condition if it receives sufficient rest, post grazing. Burrowing owls have been noted to forage and nest in seeded pasture with appropriate vegetation structure or small mammal burrows (Dechant *et al.* 2001). Vegetation height should be maintained at between 30 to 60 cm to promote optimum foraging conditions (Wellicome 1994). However, if owls are nesting in seeded pasture, maintaining shorter vegetation (less than 10 cm) within 100 m of nesting sites is preferred. No pesticides or herbicides should be applied to seeded pasture within 600 m of active burrowing owl nests (Haug and Oliphant 1990).
Disadvantages:	Native prairie habitat generally supports higher species diversity and therefore enriched prey diversity than does monoculture crops (Wellicome and Haug 1995). Conversion of native prairie to seeded pasture or cropland contributes to the increasing fragmentation of native prairie habitat, one of the primary limiting factors to burrowing owls in Alberta (Wellicome 1997). For these reasons, complementary grazing systems should ideally be created by converting cropland to seeded pasture and not by cultivating native prairie.
Rotational Grazing	
Advantages:	Rotational grazing using a 50% utilization rate would allow rest and recovery and thereby promote improved grassland range condition and suitable foraging habitat for owls within a 600 m radius of their burrows. A moderate stocking rate would help to promote vegetation patchiness and the retention of variably grazed areas. Enforced periods of rest would improve the health of riparian foraging areas.
Disadvantages:	Rotational grazing can contribute to uniform grazing effects if cattle are allowed to graze the range beyond the 50 percent utilization point (Kobriger 1980). As discussed, uniform vegetation structure diminishes burrowing owl foraging opportunities. Another disadvantage of rotational grazing systems is the need for cross-fencing which provides perching sites for predatory raptors (Felskie pers. comm.). If rotational grazing systems are used, deferred rotational grazing and switchback rotational grazing are likely preferable to rest rotation grazing. Rest-rotation systems may not be beneficial for burrowing owls, as the fields that receive a full season of rest will likely not retain the short vegetation that burrowing owls prefer for nest sites (Felskie pers. comm., Kantrud 1981, Clayton 1997, Uhmann *et al.* 2001).

Grazing System	Discussion
Intensive Grazing	
Advantages:	Burrowing owls prefer to nest in areas with short vegetation that are frequently grazed (Wellicome 1997). In an intensive grazing system cattle more evenly utilize a greater percentage of the overall range, increasing the likelihood that burrow sites would be grazed. Encouraging cattle to graze the immediate area around burrows with the use of techniques such as salting or electric fencing would likely be unnecessary under this type of grazing regime. Intensive grazing for short periods could therefore create the structural conditions that are preferred for owl nest sites, however, this could come at the expense of taller foraging habitat in the area and may cause increased disturbance to nesting owls. The disadvantages discussed below, therefore, likely outweigh the advantages of intensive grazing.
Disadvantages:	Intensive grazing systems including short duration or high intensity, low frequency grazing creates increased risks of soil erosion and compaction and can lead to uniform declines in range condition and health throughout the ranch. A general decline in range condition would likely not support stable mammal populations that require permanent, taller, denser vegetation for cover, and thereby would diminish burrowing owl foraging habitat. Burrowing owls have been shown to prey preferentially on meadow voles which have been positively correlated with vegetation height and density (Wellicome 1997). Intensive grazing would also increase trampling risks to burrowing owl chicks and nests.
Riparian Area Grazing	
Advantages:	Well managed riparian habitats are typically productive and harbour rich populations of insects and small mammals (Strand and Merritt 1999). According to a recent study in southern Saskatchewan, burrowing owl nests near to wetland areas had a higher nesting success than nests with no wetlands within 2 km (Warnock and Skeel 2002). The proximity and quality of wetland habitat protected from heavy cattle use during sensitive periods may provide an important source of additional prey for owls (Warnock and Skeel 2002, Felskie pers. comm.). Further research is required to confirm the importance of wetland and other riparian areas to burrowing owls as a source of forage supply.
Disadvantages:	If the recovery of riparian areas requires the implementation of a rest-rotational grazing system, nesting grounds in fields that receive a full season of rest may require mowing to retain short vegetation near burrowing owl nests.

1.6 Beneficial Management Practice Recommendations

The following general land use and grazing recommendations provide a variety of means by which to protect or enhance burrowing owl nesting and foraging habitat. Key to burrowing owl conservation is the protection of native prairie with a heterogeneous mosaic of areas of heavy, moderate and light grazing and areas with suitable burrow escape cover. The recommended beneficial management practices apply to burrowing owl populations within the Milk River Basin and throughout the Grassland Natural Region of Alberta. Further research is required (see Section 1.7) to improve our understanding of the role of grazing in maintaining key habitat and influencing burrowing owl predator and prey species dynamics in the Milk River Basin. The beneficial management practice recommendations should be reviewed and amended as additional local knowledge becomes available.

Important considerations for managing burrowing owl habitat are:
- protection of native grassland and traditional burrowing owl nest sites;
- availability of suitable burrows;
- maintenance of short vegetation and openness around nest burrows;
- minimal cross fencing;
- promotion of structural heterogeneity across the landscape; and
- maintenance of healthy riparian areas and key nocturnal foraging areas.

1.6.1 General Recommendations

- Protect active and historical (traditional) burrowing owl nesting sites (Haug and Oliphant 1990).
- Protect large tracts of native prairie where possible to limit further fragmentation of suitable burrowing owl habitat (Warnock 1997).
- Remove marginal farmland from production, where possible, and seed with native species to enlarge habitat patches and reduce fragmentation of burrowing owl habitat (Warnock 1997).
- Control activities within a minimum 600 m radius of the nest burrow including curtailing the use of pesticides, herbicides and rodent poisoning or eradication methods and minimizing human disturbance (Haug and Oliphant 1990, Dechant *et al.* 2001). Promote organic farming practices.
- Abide by setback distances and timing restrictions recommended by SRD, Fish and Wildlife Division for human activities, including industrial development, near to burrowing owl nests (SRD 2001b). SRD recommends a year-round set back of 500 m from burrowing owl nests for high-impact developments such as wellsites, powerlines and pipelines.
- In areas with suitable burrowing owl habitat, conduct pre-development surveys to locate burrowing owl nests to plan developments in accordance with SRD setback guidelines.
- Conserve active Richardson's ground squirrel colonies in and around active nesting sites. Grounds squirrels maintain suitable burrowing sites for burrowing owls and provide an alternate prey source for potential burrowing owl predators (Desmond *et al.* 2000, Dechant *et al.* 2001).

- Inform landowners about the beneficial ecological roles of American badgers and Richardson's ground squirrels and about preferred control techniques if control of these species is considered essential.
- Manage active or traditional nesting sites to maintain short (approximately 10 cm) and open, non-woody vegetation conditions within 100 m of nest burrows (Clayton and Schmutz 1999). This can be achieved by regular grazing (see below) or mowing, and by mechanical control of woody species encroachment.
- Encourage interagency cooperation and an ecosystem based management approach for conserving burrowing owls and their habitat.

1.6.2 Grazing Recommendations

As local site conditions play a large role in determining the best suited grazing strategy, it is likely that no one grazing system will suffice. Distribution of burrowing owls and their valued habitat components, vegetation type, topography, soil types and existing range condition and range health are all factors that must be considered in the selection and implementation of a suitable grazing system. Ultimately, flexible stocking rates and control over cattle distribution are important to the success of any grazing system. Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

The following is a list of key grazing management recommendations that can be applied to enhance or conserve burrowing owl habitat:

- Encourage regular grazing near nest burrows to maintain short vegetation (less than 10 cm) within 100 m of active or traditional nesting sites. Reduce heavy livestock use at nest sites during the nesting and brood rearing periods (May to June) to lessen potential trampling risks.
- Vary stocking rates in accordance with precipitation (decrease stocking rates in drought years, allow for increased use in wetter years).
- Promote heterogeneous habitat conditions as promoted by patch grazing with areas of high, moderate and low use and a gradation of short to tall and dense to light residual vegetation and litter cover (Felskie and Scobie pers. comm., Warnock 1997).
- Avoid intensive, high stocking rate grazing systems across large areas that encourage uniform utilization of pastures (Warnock 1997).
- Implement riparian grazing systems to maintain the function, structure and productivity of lotic (flowing water) and lentic (standing water) riparian areas that may serve as foraging areas for burrowing owls (Warnock and Skeel 2002, Felskie pers. comm.).
- Use an appropriate moderate stocking rate and an appropriate percentage of vegetation utilization in order to maintain healthy rangeland within a 600 m radius of nest burrows. This is necessary in order to provide conditions for a stable prey base for owls. A 50% proper use factor is recommended for mixedgrass prairie to retain adequate carry-over and maintain rangeland health (Adams *et al.* 1994).

- Minimize the use of cross fencing where possible to reduce predatory raptor perch sites near to suitable burrowing owl nesting habitat (Felskie pers. comm.). Experiment with the design of fence post caps to reduce their suitability as raptor perches.

1.7 Research Recommendations

Additional research is needed to compare various grazing systems in mixedgrass prairie and their effects on burrowing owl habitat and population parameters. To adequately assess the effects of grazing management practices over time on rangeland health and burrowing owl productivity and survival, trends in range condition, range health and local burrowing owl population numbers should be monitored. These factors should be assessed in conjunction with monitoring changes in stocking rates, timing of grazing and grazing distribution over time, as well as other relevant land use and climatic changes. Other factors that should be monitored are causes and rates of burrowing owl mortality, site fidelity and population dynamics, nest site vegetation structure, and burrowing owl diet relative to changes in grazing practices. This type of research would assist in the development of preferred grazing strategies to manage for burrowing owl habitat in the Milk River Basin. In general, more information is also needed regarding burrowing owl nesting-habitat requirements, diet and nocturnal foraging behaviour in the Milk River Basin specifically. Changes in burrowing owl populations and distribution over time in the Milk River Basin should also be assessed in relation to changes in Richardson's ground squirrel and badger populations.

Possible research questions to be addressed include:

- What types of grazing systems, stocking rates or percentages of vegetation utilization are beneficial to burrowing owls?
- How do burrowing owls respond to differences in grazing intensity (light, moderate and heavy grazing) in terms of productivity, nest success and juvenile survival?
- What is the desired timing and intensity of grazing near to nest burrows?
- Does cattle trampling and disturbance near nest burrows contribute to nest failure, juvenile mortality or nest abandonment?
- Does cattle presence at burrowing owl nest sites affect predation rates?
- How does grazing affect small mammal and arthropod prey species abundance and composition in the Milk River Basin?
- How important are riparian areas as a source of prey for burrowing owls, and what influence does riparian area grazing have on prey abundance and diversity?
- How does grazing and other land uses affect burrowing mammal populations (such as badgers and Richardson's ground squirrels) within the Milk River Basin? Few studies have researched the habitat preference of ground squirrels or the interaction of cattle grazing and ground squirrel herbivory (Mitchener pers. comm.).
- What are the potential benefits of prescribed burning as a management tool for maintaining burrowing owl nesting or foraging habitat? How does prescribed burning as a tool compare to grazing?

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E. LOGGERHEAD SHRIKE

1 INTRODUCTION

1.1 Background

The purpose of this report is to summarize the ecology and habitat requirements of the prairie loggerhead shrike (*Lanius ludovicianus excubitorides*) in southern Alberta. Based on this information and supporting scientific studies, various grazing systems are compared in terms of their potential implications to loggerhead shrike ecology and habitat. This discussion is followed by a summary of recommended beneficial management practices to enhance shrike habitat in the Milk River Basin in Alberta, with broader application to the range of this species within the Grassland Natural Region of Alberta (Alberta Environmental Protection 1994). Lastly, a brief summary of additional information needs that would improve our understanding of shrike ecology, habitat needs and response to land management is presented.

The prairie loggerhead shrike is a predatory songbird of Alberta's open country grasslands and parkland. The range of the loggerhead shrike in Alberta has declined over the past few decades (Prescott and Bjorge 1999). This species is ranked as "Sensitive" in Alberta and it is presently designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as "Threatened" in Western Canada (Alberta Sustainable Resource Development (SRD) 2001, COSEWIC 2002). According to the Biodiversity/ Species Observation Database (BSOD), 58 occurrences of loggerhead shrikes have been recorded in the Milk River Basin (Downey and Taylor 2003).

Fragmentation of breeding grounds and habitat loss due to conversion of native prairie to croplands have contributed to shrike population declines (Johns *et al.* 1994, Prescott and Bjorge 1999). Telfer (1992) found that areas of Alberta and Saskatchewan with the highest declines in shrike populations in recent decades had lost 30% of their unimproved pasture (native prairie) between 1946 and 1986. Areas with a fairly stable shrike population had lost a significantly lesser amount (12%) of native prairie to cropland production (Telfer 1992). A National Recovery Plan was prepared for the loggerhead shrike in 1994 (Johns *et al.* 1994). Several studies have subsequently been conducted to examine the ecology of shrikes in Alberta (Prescott and Collister 1993, Collister 1994, Collister and Henry 1995, Bjorge and Prescott 1996).

1.2 Ecology

Loggerhead shrikes return to their Alberta breeding grounds between late March to early April from wintering grounds in the southern United States and Mexico. Based on research in Alberta, shrikes typically initiate egg-laying in mid-May and lay an average of 6 eggs which are incubated from 14 to 20 days (Smith and Bjorge 1992, Collister 1994). Male shrikes are responsible for providing female shrikes with food during the incubation period as only female shrikes incubate the eggs. In southeastern Alberta, peak hatching occurs between June 2 and 10 (Collister 1994). The nestling period lasts approximately 17 to 20 days. Collister (1994) reported nest success rates of 48.7% (n=36) for 1992 and 37.8% (n=28) for 1993 for a shrike population in southeastern Alberta. Yosef (1996) reported an overall nest success of 56% for

2034 nests from various studies throughout the range of loggerhead shrikes. Shrikes have been noted to renest following failure of the first nesting attempt (Collister 1994, Yosef 1996). Collister (1994) found that replacement nests were typically built within 100 m of the first nest. Studies in Alberta found that 32% of adult shrikes returned to the same site in subsequent years, while only 1.2% of juveniles returned to the nest site (Collister and De Smet 1997). Downey and Taylor (2003) found that six out of eleven shrikes in the Milk River Basin were located in or adjacent to previously known shrike territories.

1.2.1 Diet

Loggerhead shrikes are opportunistic predators that prey on small mammals, birds, reptiles, amphibians, occasionally carrion, and insects such as grasshoppers, beetles and bees (Dechant *et al.* 2001). Shrikes are passerines and so do not have raptorial feet to handle live prey. Shrikes have evolved the unique ability to impale prey on sharp objects such as thorns and barbed wire, earning them the nickname "butcherbird" (Yosef 1996). Invertebrates constitute the majority of their diet (approximately 70%) during the breeding season, however, shrikes have been known to adjust their diet according to local prey availability (Prescott and Bjorge 1999). In Alberta, vertebrate prey commonly consumed by shrikes are thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*), meadow voles (*Microtus pennsylvanicus*) and sagebrush voles (*Lagurus curtatus*) (Prescott and Bjorge 1999).

1.3 Habitat Requirements

1.3.1 General

Loggerhead shrikes prefer flat, open habitats with scattered clumps of shrubs or hedgerows and are often found close to a variety of habitat types such as pastures, meadows, farmsteads and railroad rights-of-way (Brooks and Temple 1990, Bjorge and Prescott 1996, Dechant *et al*. 2001). In Alberta, thorny buffaloberry (*Sheperdia argentea*), willow (*Salix* spp.), or common caragana (*Caragana arborescens*) typically form the woody component of shrike habitat. A recent survey of loggerhead shrike populations in the Milk River Basin found that out of eleven sites occupied by shrikes, native grassland was the most abundant habitat type within 400 m of shrike sightings (shrike sites). Native prairie made up an average of 43% of the surrounding habitat within shrike sites, while dry land cultivation comprised 34.1% and tame pasture made up 7.3% of surrounding habitat (Downey and Taylor 2003). Six out of the eleven sites corresponded with Collister's (1994) findings that hedgerows / shelterbelts were used more frequently than single shrubs in the Milk River area. No sites occupied by shrikes were found to contain greater than 30% shrub cover (Downey and Taylor 2003).

The habitat suitability index (HSI) model for loggerhead shrikes in the Milk River Basin included four variables: shrub cover; graminoid cover; slope; and farmyards (Downey 2004). According to the HSI model, quarter sections containing at least 80% graminoids and 5% shrubs on flat terrain represent ideal loggerhead shrike habitat. Slopes greater than 15 degrees and shrub cover greater than 30% decreases the potential suitability of an area for shrikes. Farmyards increase the HSI value due to the higher potential for these sites to have shrubs and edge habitat.

1.3.2 Nesting Habitat

Wershler (1989) conducted a study of shrikes found in the Milk River region. He noted that of all the shrikes found in the Milk River region, 20% used thorny buffaloberry, 33% willow, 20% common caragana, 13% Manitoba maple (*Acer negundo*), 7% Siberian elm (*Ulmus rubra*), and 7% silver sagebrush (*Artemesia cana*). Of the nest sites found in the Milk River area, 57% were found primarily in natural shrub communities in valleys including the Milk River and in scattered upland sites and 43% of nest sites were found in exotic shelterbelts and hedgerows in cultivated areas (Smith 1991). Hellman (1994) noted that shrikes tended to avoid nesting in caragana in her Manitoba study area and preferred to nest in trees with wider canopies and larger diameters than non-nest trees. Hellman (1994) also noted that nest sites with lower amounts of understory had highest nest success.

1.3.3 Foraging Habitat

Shrikes use dead trees, tall shrubs, utility wires and fences as perches for hunting (Yosef 1996, Prescott and Bjorge 1999). Yosef and Grub (1994) identified availability of hunting perches as a limiting factor for shrike habitat. Shrikes will impale their prey on the thorns of thorny buffaloberry or other thorny shrubs, sharp twigs or barbed wire (Yosef 1996, Prescott and Bjorge 1999). Collister (1994) found that shrikes in southeastern Alberta preferred to forage in native pasture and seeded pasture and avoided cereal crops and right-of-way habitats. Although the number of forages observed in railroad right-of-way habitats was lower than expected, Collister (1994) noted that shrikes still made 722 (28%) foraging attempts and experienced the highest foraging success in this type of habitat. Collister (1994) speculated that the taller (greater than 30 cm), dense vegetation of rights-of-way may be important reserve areas for vertebrate prey when arthropod prey is scarce. Prescott and Collister (1993) found that sites occupied by loggerhead shrikes in southeastern Alberta had a greater amount of tall grass (>20 cm) than did sites that were unoccupied. In other areas of its range, researchers have highlighted the importance of short grass and grazing activity in habitat selection by breeding shrikes (Prescott and Bjorge 1999). Shorter grass provides habitat for insects, a key forage species during the breeding season. As Prescott and Bjorge (1999) note, the preference of loggerhead shrikes for "taller" grass in Alberta may not be inconsistent with results from eastern and central North America, as Alberta has a more arid climate and naturally much shorter grass heights than in more easterly areas of the continent.

Yosef and Grub (1993) examined the effect of mowing within shrike territories on the hunting behaviour and diet of shrikes. Shrikes were seen to adjust their hunting behaviour in mowed and unmowed areas, however, the rate of prey capture and the range of species captured did not vary between mown and unmown territories. Shrikes in unmown areas had increased flight time and shifted from ground hunting to aerial chase or hunting from a hover, resulting in an overall increase in net energy expenditure.

1.3.4 Area Requirements

Loggerhead shrike breeding territories along a railroad-right of way in southeastern Alberta were found to be asymmetric and averaged 8.5 ha (Collister 1994). Collister (1994) noted that the mean maximum radius of excursion from loggerhead shrike nests over two years ranged up to 360 m.

1.4 Loggerhead Shrike Response to Grazing

Cattle grazing has the potential to impact loggerhead shrikes directly and indirectly. Rubbing or browsing by cattle on shrubs used for nesting can cause nest destruction or abandonment (Pittaway 1991). Cattle herbivory affects the availability and composition of loggerhead shrike prey species by altering vegetation structure and plant species composition.

Few studies have compared the merits of various grazing systems for loggerhead shrikes. However, several studies in the United States have assessed the response of shrikes to various intensities of grazing. In the shrubsteppe habitats of Nevada, Idaho and Utah studies have shown that loggerhead shrikes have either increased in abundance or have not been affected by heavy to moderate grazing (Saab *et al.* 1995). Similarly, in Virginia and South Carolina, Luukkonen (1987), Gawlik (1988) and Gawlik and Bildstein (1990) suggest that grazed areas are preferred loggerhead shrike habitat. Blumton (1989) found that shrike productivity was highest in areas with grasses of medium height (9.1 to 18 cm) in comparison to similar areas with shorter or taller grass. However, as noted by Prescott and Collister (1993), heavy grazing may be limiting to loggerhead shrikes in southern Alberta since shrikes were found to occupy habitats with a higher percentage of tall ($\geq$20 cm) grass and avoided habitats with shorter grass (<20 cm). This observation may have been an indication of greater prey abundance in taller grass habitats, however, further research is needed to investigate the relative abundance of prey and the frequency of foraging by shrikes in grazed versus ungrazed grasslands. Mills (1979) reported that nonbreeding shrikes preferred to forage in areas of short grass, but would feed in taller vegetation if prey availability was higher.

1.5 Grazing Systems and Loggerhead Shrike Habitat Management

Table III-7 provides an overview of five pertinent grazing systems and their potential positive and negative implications to loggerhead shrikes and their habitat. A grazing system is a tool used to control the spatial distribution, timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003). Applied research is needed to properly assess the effects of various grazing systems on loggerhead shrikes in the Milk River Basin.

Table III-7 Grazing Systems and Loggerhead Shrike Habitat Management

Grazing System	Discussion
Continuous (Season-Long) Grazing	
Advantages:	Continuous grazing at moderate stocking rates can be beneficial to loggerhead shrikes if it promotes patchy grazing with some areas lightly grazed and other areas more heavily grazed. This type of grazing pattern creates a heterogenous habitat that promotes refugia for small mammals and also stimulates plant species diversity and in turn insect diversity. As loggerhead shrikes prey primarily on insects during the summer, grazing systems that stimulate insect diversity but do not promote damaging "pest" species are desirable. Based on a study of grasshopper species in the mixed and fescue prairie in southern Alberta, Hardman and Smoliak (1982) concluded that the majority of grasshopper species that can cause the most damage to rangeland preferred sparsely vegetated habitats such as heavily grazed range. Jonas *et al.* (2002), in their study of the response of arthropods to various land use types in Central Kansas, concluded that the diversity and richness of all arthropod groups examined (specifically Coleoptera [beetles] and Orthoptera [crickets and grasshoppers *etc.*]) were positively correlated with plant species diversity and richness. Willoughby (1993) noted that plant species diversity was higher in moderately grazed areas than in overgrazed or ungrazed sites in fescue prairie in southwestern Alberta.
Disadvantages:	Intensively stocked continuously grazed systems can have a detrimental impact on the quality and availability of suitable shrubs for nesting. Under continuous grazing systems, cattle pressure on wetlands and small riparian zones is typically increased. Persistent grazing during the dormant season will progressively set back woody species (Fitch and Adams 1998). Heavy browsing can deplete root reserves and inhibit the establishment and regeneration of woody species, ultimately leading to invasion by disturbance or weedy species (Fitch and Adams 1998). Physical damage by rubbing and trampling, if persistent, can also kill off woody vegetation. The die-off or decline in cover values of shrubs and willows reduces the number and quality of suitable nesting sites for loggerhead shrikes.
Complementary Grazing	
Advantages:	Complementary grazing, a form of deferred grazing, may be beneficial to loggerhead shrikes by allowing for deferred grazing of native prairie until the end of June, with seeded pasture grazed earlier in the season. This delay allows shrikes to complete nesting and fledge young in shrubs near wetlands or riparian areas or in upland native prairie prior to cattle grazing in these areas. Late season grazing (after July) is preferred over early season grazing to allow for improved ground cover and litter accumulation, particularly for areas of mixedgrass prairie that have been heavily grazed (Naeth *et al.* 1991).
Disadvantages:	In his study of loggerhead shrikes in southern Alberta, Collister (1994) noted that the majority of shrikes nested within native pasture. Habitat within territories averaged approximately 52% native pasture and only 8% seeded pasture. Loss of native prairie habitat to seeded pasture to facilitate complementary grazing would therefore not be beneficial to shrikes.
Rotational Grazing	
Advantages:	One of the immediate benefits of rotational grazing systems to loggerhead shrikes is an increase in the availability of suitable perch sites. Yosef and Grubb (1994) found that habitat suitability for shrikes in their Florida study area was enhanced by introducing hunting perches such as fence posts. The addition of fence post perches allowed shrikes to forage in previously unsuitable areas and thereby reduce the size of their territories. Reducing the size of existing territories may allow more territories to be fitted into a given area and thereby increase the size of a local population (Yosef and Grubb 1994). A reduction in territory size may have associated benefits to the nutritional condition

Grazing System	Discussion
Rotational Grazing Cont'd.	
Advantages:	of adult shrikes. Smaller territories mean shrikes expend less energy in defense of a larger, unused area and capitalize on nutritional gains from a smaller, better utilized area that is more easily defended (Yosef and Grubb 1994). Yosef and Grub (1994) noted that significantly more young were fledged in manipulated territories. Deferred rotational grazing systems may also improve the prey base available to shrikes by improving the overall condition of the range by allowing for periodic rest and recovery and improved litter cover. Periodic seasonal rest also allows for improved health of shrub vegetation that is not consistently grazed at the same period each year.
Intensive Grazing	
Advantages:	Heavy grazing can lead to an increase in grasshopper density, and correspondingly loggerhead shrike prey abundance. In their study of fescue grasslands at the Stavely Research Station in southern Alberta, Holmes *et al.* (1979) collected more grasshoppers from heavily and very heavily grazed fields than light to moderately grazed fields.
Disadvantages:	Intensive grazing systems force cattle to be less selective when grazing and encourages more even distribution of grazing across the range. Cattle will graze all types of available forage including shrubs and woody browse, which would not be ordinarily favoured. This creates obvious pressures on shrubs used for nesting. Intensive grazing systems are also typically detrimental to the viability of riparian areas and associated shrike nesting habitat. In addition, intensive grazing for prolonged periods may be detrimental to the availability of small mammal prey (Fagerstone and Ramey 1996).
Riparian Area Grazing	
Advantages:	Although shrikes are primarily found on flat prairie, small riverine riparian zones are likely beneficial in providing them with nesting sites if they contain large flat valleys with shrubs such as the Lost River located within the Milk River Basin Basin (Downey 2004). Wetland riparian areas are especially important for shrikes in the drier areas of southeastern Alberta due to their higher potential for supporting shrub growth (Downey 2004). Riparian area grazing systems including rotational grazing, corridor fencing and riparian pastures, are all geared toward protecting the health and integrity of riparian systems. Protecting the vitality of deeply rooted woody species such as willows and large shrubs such as thorny buffaloberry is vital to maintaining bank stability, trapping sediment and reducing erosion. Therefore the goals of riparian area management are consistent with wildlife habitat goals such as providing nesting and foraging habitat for loggerhead shrikes.
Disadvantages:	In the absence of well managed riparian area grazing, cattle will tend to linger in these areas and cause degradation of riparian area vegetation and overall riparian health. As discussed, heavy utilization of shrubs and trees in riparian areas prevents the establishment of seedlings and can ultimately eliminate woody vegetation entirely from these sites. This has obvious negative implications to loggerhead shrike nesting and foraging opportunities. Planning suitable riparian area grazing systems, however, should not come at the cost of degrading upland prairie range health. The design of riparian area grazing strategies must therefore consider management of the overall rangeland unit.

1.6 Beneficial Management Practice Recommendations

The following general land use and grazing recommendations provide a variety of means by which to protect or promote loggerhead shrike nesting and foraging habitat. The suggested beneficial management practices apply to loggerhead shrike populations within the Milk River Basin and throughout the Grassland Natural Region of Alberta. The recommendations are based on the current knowledge of loggerhead shrike ecology and habitat use in the Milk River Basin and its greater breeding range in North America. Further research is required (see Section 1.7) to improve our understanding of the influence of grazing as well as loggerhead shrike habitat requirements in the Milk River Basin. The beneficial management practice recommendations should be reviewed and amended as additional knowledge becomes available.

1.6.1 General Recommendations

- Protect remaining native prairie (Telfer 1992). Where land has been cultivated, maintaining seeded pasture is preferred to cereal cropland production (Telfer 1992, Dechant *et al*. 2001).
- Protect and manage for healthy lotic (flowing water) and lentic (standing water) riparian woody edge habitat.
- Protect silver sagebrush (Woods and Cade 1996) and upland shrubland habitat (Downey 2004).
- Protect abandoned railroad right-of-way habitat and enhance through native shrub plantings (*e.g.* thorny buffaloberry) where necessary (Collister 1994).
- Plant willow (*Salix* sp.), thorny buffaloberry or other like native shrubs in areas where these species have been removed or in areas where woody species are not naturally regenerating due to heavy browsing pressure (Telfer 1992, Dechant *et al.* 2001). Planting of shrubs is recommended particularly in areas with high vegetation diversity (such as the border of tame and native pastures and road allowances) and near fences (Telfer 1992, Bjorge and Prescott 1996). Telfer (1992) recommends planting one patch of thorny buffaloberry or willow per quarter section in suitable locations as a means to improve shrike habitat.
- Maintain shelterbelts around old farmsteads and field edges (Collister 1994, Dechant *et al.* 2001). Investigate the benefits of diversifying shelterbelts by planting native thorny shrubs such as thorny buffaloberry or hawthorn (*Crataegus* spp.) as well as planting or leaving a 2 to 4 m grassy areas along shelterbelts to increase foraging areas near nests (Hellman 1994).
- To reduce the potential for increased predation pressure due to systematic sampling, use means to reduce the linear nature of shelterbelts and avoid planting shrubs in linear strips along fence lines (Yosef 1994). For example, plant multiple, irregular patches of shrubs or trees along shelterbelts and create larger blocks of habitat adjacent to strips of woody vegetation (Dechant *et al.* 2001).
- Preserve tree and shrub growth in abandoned farmyards (Bjorge and Prescott 1996).
- Reduce or avoid the use of insecticides and organochlorides to avoid contamination of loggerhead shrike prey species (Dechant *et al*.2001).

- Maintain graminoid and herbaceous cover dominance versus dense woody species encroachment (Brooks and Temple 1990, Downey 2004). Five percent shrub cover on flat terrain is considered preferred shrike habitat in the Milk River Basin (Downey 2004). Where woody cover exceeds 30% in formerly suitable shrike habitat, investigate the use of prescribed burning, or trimming and manual removal of shrubs and trees as opposed to the use of herbicides or frequent mowing (Yosef 1996).

1.6.2 Grazing Recommendations

Appropriate grazing systems for loggerhead shrikes should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

Grazing systems that will benefit loggerhead shrikes should perform the following functions:
- promote plant and insect species diversity;
- provide habitat for small mammals; and
- provide areas of undisturbed or minimally disturbed shrubby nesting habitat in relatively flat sites (upland or lowland) during the breeding season.

To provide these characteristics, the following grazing management principles should be applied:

- Promote heterogeneous vegetation heights by encouraging light to moderate grazing at suitable proper use factors for fescue (40%) and mixed grass prairie (50%) (Adams *et al.* 1994).
- Retain areas of taller grass (>20 cm) near to suitable shrike nesting habitat to serve as food reserves for small mammals (Prescott and Collister 1993).
- Manage cattle grazing in riparian areas and near to shrubs used for nesting by using fencing or timing use of these areas to avoid the peak nesting season (mid-May to mid-June). Note that as female shrikes sometimes mate with more than one male or switch mates, managers should aim to provide suitable breeding areas large enough to support several, asymmetrically shaped average-sized territories (approximately 5.9 to 6.7 hectares / territory) (Haas and Sloane 1989, Collister 1994).
- Conduct riparian health assessments to determine the composition, age class, canopy cover and percent utilization of woody species. Implement riparian grazing systems where necessary to improve riparian health and thereby improve cover of woody species.

1.7 Research Recommendations

Further research is required to compare shrike productivity and survival under various grazing systems and to evaluate the specific benefits and possible detriments of grazing on shrikes. For example, studies could be conducted that:

- examine differences in loggerhead shrike invertebrate and vertebrate prey abundance and composition in light, moderate, and heavily grazed grasslands in the Milk River Basin;
- evaluate the frequency of foraging by shrikes in grazed versus ungrazed grassland; and
- compare shrike productivity and other population parameters in habitat managed under continuous, rotational and complementary grazing systems.

Additional studies are needed to evaluate differential nesting success of loggerhead shrikes in natural shrub communities versus shrikes nesting in exotic linear shelterbelts and farmyard hedgerows in the Milk River Basin. This type of study would evaluate whether linear shelterbelts are searched systematically by predators or are subject to higher predation pressure due to concentration of prey species, greater edge habitat and greater diversity of predatory species (Yosef 1994, Haas 1997). Therefore the goal of this research would be to determine whether shelterbelts constitute “sink” versus “source” habitats for shrikes (Yosef 1994). This information is important to evaluate the quality of shelterbelts as shrike nesting habitat in comparison to natural shrubby corridors.

To more thoroughly determine the preferred types and structural characteristics of suitable nest shrubs and associated vegetation, more detailed information on shrike habitat within the Milk River Basin needs to be gathered. This includes acquiring information on grass height, litter cover, and shrub species type, height, canopy cover, percent utilization and basal diameter. Nesting habitat information should be analysed in relation to shrike productivity data.

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F. GRASSLAND BIRD GROUP

1 INTRODUCTION

The purpose of this report is to summarize and compare the ecology and habitat requirements of four grassland birds found within the Milk River Basin: long-billed curlews (*Numenius americanus*), upland sandpipers (*Bartramia longicauda*), Sprague's pipits (*Anthus spragueii*) and Baird's sparrows (*Ammodramus bairdii*). Based on this information, the potential effects of grazing and various grazing systems on grassland birds and their habitats are discussed. This discussion is followed by a summary of recommended beneficial management practices to enhance grassland bird habitat in the Milk River drainage in Alberta. These recommendations can be applied to the range of these species within the Grassland Natural Region of Alberta (Alberta Environmental Protection 1994). Lastly, a brief summary of additional information needs is presented.

Long-billed curlews, Sprague's pipits and Baird's sparrows are three of nine grassland birds that are considered primary endemic species of the Great Plains, having evolved and occurring exclusively on the prairies of North America (Knopf 1996a). Upland sandpipers are one of twenty grassland birds that are considered secondary or more widespread species but that have a strong affinity to the Great Plains (Knopf 1996a). Due in large part to the tremendous loss, fragmentation and alteration of native prairie, endemic grassland birds as a group have reportedly "shown steeper, more consistent, and more geographically widespread declines than any other behavioural or ecological group of North American species" (Knopf 1996a, p.147).

Presently, long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows as well as their eggs and nests are protected from hunting or collection in Canada under the *Migratory Birds Convention Act* of 1994. All of these species are further protected as "non-game animals" under Alberta's *Wildlife Act*. Despite these forms of protection, grassland birds continue to be threatened by habitat loss or current agricultural practices. Native prairie offers the greatest potential to retain habitat for grassland birds, particularly if livestock grazing can be used to enhance or maintain suitable habitat. Historically, bison grazing on the Great Plains played a major role in stimulating variation in vegetation structure which in turn created habitat for a diversity of bird species.

2 LONG-BILLED CURLEW

2.1 Background

Long-billed curlews, North America's largest shorebird, breed preferentially in mixedgrass and fescue prairie and sandhills in southern Alberta (Prescott and Bilyk 1996, Saunders 2001). *Numenius* translated as "crescent moon", refers to the curlew's distinctive, long down-curved bill (Dugger and Dugger 2002).

Within Canada, long-billed curlews breed predominately in the Grassland Natural Region of southern Alberta, in south-central and southwestern Saskatchewan and in the dry grasslands of southern interior British Columbia (Hill 1998). In the United States, curlews breed in shortgrass and mixedgrass habitats of the Great Plains, Great Basin and intermontane valleys of 16 states in the northwestern, central and south-central regions (Hill 1998, Dugger and Dugger 2002). The largest remaining populations in the Great Plains occur in Montana (Hill 1998). The long-billed curlew winter range includes coastal and inland habitats in the southern United States (primarily in California, Texas and Louisiana) and extends into Mexico and Central America (Hill 1998, Dugger and Dugger 2002).

Formerly abundant throughout most of the prairie regions in Canada and the United States, long-billed curlew populations have declined substantially throughout their breeding and wintering range since the early 1900s (Hill 1998, COSEWIC 2002a). Curlews have been extirpated from Kansas, Michigan, Iowa, Minnesota, Wisconsin, eastern Nebraska, Illinois, Manitoba, and southeastern Saskatchewan (Hill 1998). The minimum population estimate of long-billed curlews in Canada is 23,500 birds; the majority of these birds (approximately 80%) breed in Alberta (COSEWIC 2002a). Suspected population declines in Alberta prompted its designation as "May Be At Risk" of extirpation at the provincial, general status level (SRD 2001a). It was also recommended in 2000 as a "Species of Special Concern" in Alberta under the *Wildlife Act* by the Alberta Endangered Species Conservation Committee (ESCC). At the national level in Canada, the long-billed curlew is presently listed as a species of "Special Concern" (*i.e., "*a species that is particularly sensitive to human activities or natural events") by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2002a).

Over-hunting in the 1800s and early 1900s and elimination of breeding habitat are thought to be primarily responsible for curlew declines, particularly in the eastern half of their historic range (Dugger and Dugger 2002). Loss or degradation of prairie breeding habitat is presently considered among the greatest threats to the stability of curlew populations (Renaud 1980, De Smet 1992, Hill 1998, Saunders 2001, Dugger and Dugger 2002). Agriculture and industrial and urban development are dominant causes of habitat loss (Dugger and Dugger 2002). Although not as significant as habitat loss, the use of organochlorine pesticides have caused documented mortalities and other sublethal effects in long-billed curlews (Blus *et al*. 1985).

2.2 Ecology

Long-billed curlews arrive on breeding grounds in southern Alberta in mid to late April (Hill 1998, Saunders 2001). Nest building usually begins in early May, and the nesting period typically lasts until mid-June, with brood rearing occurring from June into July, and possibly into early August (Renaud 1980, Hill 1998). Curlews are extremely territorial during the breeding season, vigorously defending a nesting territory from prelaying through to chick-hatching (Dugger and Dugger 2020).

Long-billed curlews are considered to have a low reproductive output and are a long-lived, late maturing species (Hill 1998). The average age at first breeding is 3 to 4 years for males and 2 to 3 years for females (Redmond and Jenni 1986). On average, curlews have an 8 to 10 year life-span (Redmond and Jenni 1986). Females usually lay one clutch each breeding season, with clutch sizes ranging from 2 to 5 eggs; most commonly 4 eggs (Dugger and Dugger 2002). Re-nesting following nest failure is considered rare (Redmond and Jenni 1986). A full clutch takes 4 to 7 days to complete, with eggs laid on alternate days (Hill 1998). Both females and males will incubate the eggs; the females will sit during the day and the males at night (De Smet 1992). The incubation period generally lasts 27 to 30 days (Dugger and Dugger 2002). Curlew chicks will hatch synchronously often within a period of 5 hours (Hill 1998). Chicks are precocial, meaning they are capable of walking and feeding themselves shortly after hatching (Dugger and Dugger 2002). Broods are actively defended, especially by the male (Dugger and Dugger 2002). Adult females often abandon broods at 2 to 3 weeks after hatching, after which time the male will care for the young until they fledge, approximately 41 to 45 days after hatching (Hill 1998). Male long-billed curlews are often more likely to return to a breeding area than females (Redmond and Jenni 1982). If a female loses a clutch or is exposed to excessive disturbance during nesting, she is less likely to return to the same nesting area in subsequent years than successful females (Redmond and Jenni 1982).

Long-billed curlews form post-breeding flocks in July and August in preparation for the fall migration (Hill 1998). Most curlews leave Alberta on route south by the end of August (Hill 1998).

2.2.1 Diet

Curlews are considered opportunistic foragers on breeding grounds, foraging primarily on grasshoppers and beetles, and occasionally on small vertebrates such as bird eggs and nestlings (horned larks (*Eremophila alpestris*) in particular) (Sadler and Maher 1976, Redmond and Jenni 1985, Dugger and Dugger 2002). A study in western Idaho investigated the diet of long-billed curlew chicks (Redmond and Jenni 1985). Five insect orders and one arachnid order were identified from the stomach contents of nine chicks; grasshoppers and carabid beetles dominated the diet samples (Redmond and Jenni 1985).

The long, decurved bill of this curlew is thought to be an adaptation for foraging for earthworms or burrowing species like crab or shrimp in the tidal mudflats of their winter ranges (Dugger and Dugger 2002). When long-billed curlews forage in breeding grounds they use a pecking method whereas in their winter ranges they tend to use a probing method (Dugger and Dugger 2002).

2.2.2 Predators

As a ground nesting species, long-billed curlew eggs, nests and chicks are prone to predation by avian and mammalian predators (Redmond and Jenni 1986, Pampush and Anthony 1993, Dugger and Dugger 2002). A study in western Idaho found that 42% of all curlew clutches failed; predators were responsible for the majority (84%) of nest failures (Redmond and Jenni 1986). Redmond and Jenni (1986) found that badgers (*Taxidea taxis*) and canids (including coyotes (*cannis latrans*), red fox (*Vulpes vulpes*) and feral dogs (*Canis familiaris*)) were the most significant predators of long-billed curlew eggs and clutches in Idaho. Other common predators of curlew eggs include black-billed magpies (*Pica pica*), common ravens (*Corvus corax*), American crows (*Corvus* brachyrhynchos) and bullsnakes *(Pituophis melanoleucus*) (Allen 1980, Redmond and Jenni 1986, Pampush and Anthony 1993). Predators that target curlew chicks include Swainson's hawks (*Buteo swainsonii*), ferruginous hawks (*Buteo regalis*), great horned owls (*Bubo virginianus*), black-billed magpies and weasels (*Mustela* spp.) (Allen 1980, Redmond and Jenni 1986). Long-billed curlews rely on the cryptic colouring of their plumage and eggs to evade predators (Redmond 1986). Curlews will also clump their breeding territories in loose aggregations to aid in predator defense (Hill 1998, Saunders 2001).

2.3 Habitat Requirements

2.3.1 General

Long-billed curlews typically occur in open expanses of level to gently rolling short-grass and mid grass native prairie habitats during the breeding season (Renaud 1980, Hill 1998, Dechant *et al.* 2003a). A recent population survey in southern Alberta, found a positive relationship between curlews and native prairie during the breeding season. Curlews were twice as numerous in areas comprised of more than 50% native prairie than in areas containing lesser amounts (0 to 50%) of native prairie (Saunders 2001). Although curlews showed a preference for native prairie, 36% of curlew observations were in cultivated areas (Saunders 2001). Saunders (2001) also reported a negative correlation between curlews and riparian areas. Similarly, Gratto-Trevor (1999) found that curlew nests near Brooks, Alberta were greater than 1 km from permanent waterbodies (including dugouts). This contrasts research in Colorado, where the majority of curlew observations were within 400 m of water (McCallum *et al.* 1977). Owens and Myres (1973) found that long-billed curlews were 4.5 times more abundant in native prairie than in cultivated lands near Hand Hills, Alberta. In the Southern Prairie Biome[2] of Alberta, Prescott and Bilyk (1996) observed long-billed curlews in 16.7% of sandhill sites (n=12) and fescue sites (n=18); 22.2% of native mixedgrass sites (n=27); and in 6.3% of seeded pasture sites (n=16). Curlews were similar in abundance in the fescue, mixedgrass and sandhill sites, and were half as numerous in seeded pasture sites (Prescott and Bilyk 1996). In the Suffield National Wildlife Area in southern Alberta, curlews were most abundant in upland grassland and disturbed grassland (*i.e.,* formerly cultivated, mowed or heavily grazed), as well as moist grasslands (Dale *et al.* 1999).

2.3.2 Nesting Habitat

Curlew nesting habitat characteristics vary throughout their range, however, in general, curlews nest in open expanses of short (less than 10 cm to 20 cm) grassland with flat to rolling topography (Allen 1980, Hill 1998, Dugger and Dugger 2002, Dechant *et al.* 2003a). Curlews tend to avoid nesting in treed areas, grasslands with a high density of shrubs or in tall (greater than 30 cm), dense grasslands (Pampush and Anthony 1993, Dugger and Dugger 2002, Dechant *et al.* 2003a). Although curlews will occasionally nest in cropland, fallow, hayland or stubble fields with a similar vertical profile as shortgrass prairie, extensive areas of cultivated land are not considered preferred nesting habitats (Renaud 1980, De Smet 1992, Hill 1998, Dechant *et al.* 2003a). Four important nesting habitat requirements identified in Oregon, included: 1) short grass (generally less than 30 cm); 2) bare ground; 3) shade; and 4) abundant invertebrate prey (Pampush and Anthony 1993).

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[2] The Southern Prairie Biome encompasses grasslands south of the South Saskatchewan and Oldman Rivers, and west of the Rocky Mountain foothills (Prescott and Bilyk 1996).

In north-central Oregon, curlew nest density was negatively correlated with vegetation height and vertical density (Pampush and Anthony 1993). Curlews preferentially nested in exotic downy brome (*Bromus tectorum*) habitats and avoided native bunchgrass habitats (Pampush and Anthony 1993). Allen (1980) also documented a preference for curlews to nest in downy brome vegetation less than 10.0 cm tall in southeastern Washington. In Utah, curlew nest sites had significantly shorter vegetation than in surrounding areas (5.7 cm versus 9.0 cm) (Paton and Dalton 1994). Low shrub cover and a low vegetative profile are suspected to be important for predator detection and avoidance as well as effective communication between nesting birds (Allen 1980, Pampush and Anthony 1993). Vegetation patchiness at nest sites (*i.e.,* uneven vegetation height and the irregular spacing of grass clumps) and the placement of nests near conspicuous objects such as livestock manure piles, rocks, or dirt mounts may also be important for predator avoidance (Allen 1980, Pampush and Anthony 1993, Dugger and Dugger 2002).

2.3.3 Brood Rearing Habitat

Although curlews usually nest in areas with shorter vegetation, curlew broods require areas with taller, denser grass, to provide shade and cover from predators (Maher 1973, Allen 1980, Hill 1998, Dugger and Dugger 2002). Adults move broods to areas with higher vegetation shortly after eggs hatch; one brood was reported to have moved more than 6 km in a six day period (Maher 1973). Chicks usually leave the nest within a few hours of hatching (Dugger and Dugger 2002). Curlew broods are known to use cropland, stubble fields and weedy areas to a greater extent during the brood rearing period, especially if vegetation at the nest site is sparse (Maher 1973, 1974, Allen 1980, Renaud 1980, Pampush and Anthony 1993, Dechant *et al.* 2003a).

2.3.4 Foraging Habitat

In general, open, sparse grasslands offer preferred foraging habitat for adult long-billed curlews (Dechant *et al.* 2003a, Dugger and Dugger 2002). It is suspected that short vegetation (less than 10 cm) facilitates predator detection and is easier for a long-billed bird to forage in than in tall, dense vegetation (Redmond 1986, Dugger and Dugger 2002). Breeders may forage within or outside nesting territories (Pampush and Anthony 1993). Curlews are known to forage in grasslands, cultivated fields, stubble fields and wet meadows (Dechant *et al*. 2003a).

In shortgrass prairie and seeded pasture in Idaho, Bicak *et al.* (1982) found that curlew prey capture rates were higher in areas with shorter grass (less than 10 cm), despite higher prey densities in taller vegetation. Similarly, Redmond (1986) found that curlews in Idaho foraged mainly in shortgrass prairie with vegetation heights of 3.6 cm to 9.7 cm. A year of high spring rainfall resulting in tall (10 cm to 40 cm), dense grass cover and thick, standing-dead vegetation, hindered curlew foraging, prompting curlews to travel up to 10 km from territories to forage in agricultural lands (Redmond 1986). Resultant increased energy expenditure is thought to have negatively affected curlew productivity that year (Redmond 1986). In Oregon, Pampush and Anthony (1993) noted that curlews used swathed alfalfa as a foraging area, but not as a nesting area. Alfalfa fields were used for foraging until plant growth exceeded 30 cm (Pampush and Anthony 1993).

Long-billed curlews may forage singly or in groups of 3 to 14 (Dugger and Dugger 2002). If there is a high density of grasshoppers, they are most likely to forage in groups. It has been suggested that curlews may forage co-operatively as foragers tend to move in the same direction, either side by side or in a line (Dugger and Dugger 2002).

2.3.5 Area Requirements

Area requirements for long-billed curlews appear to be associated with the type and amount of vegetation and topography (Dechant *et al*. 2003a). In southeastern Washington, areas with open, flat, less diverse habitat supported larger curlew territories than did areas with more diverse topography and that had shrubby vegetation near the nest sites; territories ranged from 14 ha to 20 ha in the former habitat and from 6 ha to 8 ha in the latter habitat (Allen 1980). Dechant *et al.* (2003a) suggest that curlews require a minimum habitat area of at least 42 ha, which is approximately three times as large as the average size of a long-billed curlew territory (approximately 14 ha).

Saunders (2001) reported a mean curlew density of 0.18 pairs per km^2 in habitats with 51% to 100% native grassland in southern Alberta. Curlew densities were approximately two times lower in habitats with less than 50 percent native prairie. In East Kootenay, British Columbia, curlews only nested in grassland openings that were greater than 250 m in diameter (Ohanjanian 1992 in COSEWIC 2002a).

3 UPLAND SANDPIPER

3.1 Background

Like long-billed curlews, upland sandpipers are shorebirds that are specialized to breed in dry upland grasslands (Houston and Bowen 2001). The upland sandpiper is considered a regular breeder in the Grassland Natural Region of Alberta (Semenchuk 1992). The main, contiguous, portion of the upland sandpiper breeding range extends south from southern Canada to the central United States and east from the Rocky Mountains to the Appalachian Mountain region (Houston and Bowen 2001). The majority (approximately 79%) of the continental population of upland sandpipers is found in South Dakota, North Dakota, Nebraska and Kansas. Small, isolated breeding populations occur in high-altitude meadows in Washington, Oregon, Idaho, Alaska and Yukon as well as the southwest corner of the North West Territories. Within Canada, upland sandpipers breed in the southern regions of Alberta, Saskatchewan and Manitoba. Upland sandpipers winter in South America.

The status of upland sandpipers in Alberta is unclear as there is limited, long-term population trend information available (Semenchuk 1992, SRD 2001a). In 2001, the estimated Canadian population of upland sandpipers was approximately 10,000 individuals (Morrison *et al.* 2001). Upland sandpipers are considered "Sensitive" in Alberta at the general status level (SRD 2001a). The status of this species has not yet been determined at a national level by COSEWIC. Initially abundant across the grasslands of North America, upland sandpiper populations plummeted during the late 1880's and early 1900's throughout their former range (Houston 1999). Breeding Bird Surveys from 1966 to 1999 suggest that upland sandpiper populations are continuing to decline throughout North America, with the possible exception of North Dakota (Houston and Bowen 2001).

Overhunting in its breeding and wintering grounds in the 1800's and early 1900's and conversion of vast tracts of habitat to croplands are thought to have played a major role in the initial decline of this species (Houston 1999, Houston and Bowen 2001). Habitat loss, fragmentation and degradation due to human activities continue to have an impact on upland sandpiper populations throughout much of their breeding range (Buhnerkempe and Westemeier 1988, Helzer and Jelinski 1999, Houston and Bowen 2001).

3.2 Ecology

Upland sandpipers arrive in Alberta from early to mid-May, and depart by late August or early September (Semenchuk 1992). Breeding pairs usually arrive on breeding grounds approximately 14 days prior to nest initiation (Houston and Bowen 2001). Pairs typically arrive together, or form shortly after arrival (Houston and Bowen 2001). Upland sandpipers often return to the same breeding site in subsequent years (Ailes 1976, 1980, Dorio 1977, Houston and Bowen 2001). In Alberta, nesting usually occurs from mid-May to the end of June, and brood rearing takes place from June until early August (Kantrud and Higgins 1992, Semenchuk 1992, Houston and Bowen 2001).

Upland sandpipers are typically non-territorial, seldom nesting alone and more often nesting in loose colonies (Houston and Bowen 2001). Feeding and loafing areas are usually shared with other adults and broods (Ailes 1980, Houston and Bowen 2001). Normally 4 eggs are laid; cultch sizes range from 2 to 7 (Houston and Bowen 2001). Most commonly, one brood is raised per season (Semenchuk 1992). Eggs are usually incubated for a period of 23 to 24 days (Houston and Bowen 2001). Both sexes share incubation although the male is often more persistent (Ailes 1976). Chicks are precocial and leave the nest shortly after hatching, thereafter they are tended by both parents (Semenchuk 1992). Young fledge within 32 to 34 days (Ailes 1980).

3.2.1 Diet

Upland sandpipers feed mainly on terrestrial insects (such as grasshoppers and weevils), spiders, snails and earthworms (Houston and Bowen 2001). Lesser amounts of waste grains and weed seeds are also eaten (Houston and Bowen 2001).

3.2.2 Predators

Upland sandpiper adults, eggs and chicks are most commonly susceptible to mammalian predators such as coyote, badger, raccoon (*Proycon lotor*), striped skunk (*Mephitis mephitis*), mink (*Mustela vison*) and red fox (Houston and Bowen 2001). Common avian predators include: American crow, golden eagle (*Aquila chrysaetos*), northern goshawk (*Accipiter gentilis*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*) and snowy owl (*Nyctea scandiaca*) (Houston and Bowen 2001).

Out of 617 nests in South Dakota, North Dakota, Montana and Manitoba, 32% (197 nests) were destroyed; mammalian predators were responsible for 66% of nest losses (Kantrud and Higgins 1992). Avian predators were responsible for significantly fewer (3%) nest losses (Kantrud and Higgins 1992).

3.3 Habitat Requirements

3.3.1 General

In general, upland sandpipers use habitats with "low to moderate forb cover, low woody cover [*i.e.,* minimal shrub or tree growth], moderate grass cover, moderate to high litter cover, and little bare ground" (Dechant *et al.* 2003b). Fence posts and other display perches are also considered important habitat components (Dechant *et al.* 2003b). Upland sandpipers utilize native prairie, seeded pasture, hay fields and wet meadows, as well as planted cover such a cropland and grassy rights-of-way adjacent to roads or railroads (Dechant *et al.* 2003b). Native prairie habitats are typically preferred over cultivated lands (Kantrud and Higgins 1992). Native prairies appear to provide a more structurally suitable, secure, and potentially more productive habitat than cultivated fields (Kirsh and Higgins 1976, Ailes 1980, Kantrud and Higgins 1992, Dechant *et al.* 2003b). Upland sandpipers in Manitoba were found to be significantly more abundant in native mixedgrass prairie than in sites dominated by exotic species including smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*) and leafy spurge (*Euphorbia esula*). In Saskatchewan, upland sandpipers were present in low abundance in both native mixedgrass and crested wheatgrass seeded pastures (Sutter and Brigham 1998). In the Hand Hills of southern Alberta, upland sandpipers were 2.3 times more abundant in native fescue grassland than in cultivated areas (Owens and Myres 1973).

Upland sandpipers use habitats with a range of vegetation heights over the course of the breeding season (Dechant *et al.* 2003b). Areas with short vegetation (less than 30 cm) are used for foraging (Dorio 1977, Dorio and Grewe 1979, Bolster 1990); taller vegetation (10 cm to 64 cm) provides suitable cover for nesting (Higgins *et al.* 1969, Ailes 1976, Kaiser 1979, Buhnerkempe and Westemeier 1988); and short to intermediate vegetation (less than 15 cm) is used for brood rearing (Ailes 1976, Dorio 1977, Dorio and Grewe 1979, Ailes 1980, Buhnerkempe and Westemeier 1988, Bolster 1990). To meet these habitat requirements upland sandpipers will use areas with varying amounts and types of disturbance. Grazed, burned and hayed fields generally provide suitable foraging and brood rearing habitats, while undisturbed or lightly grazed areas are used for nesting (Dechant *et al.* 2003b).

3.3.2 Nesting Habitat

Upland sandpipers are ground nesters that have been found to nest in a variety of habitats (including native and seeded vegetation) with varying vegetation heights and densities (Houston and Bowen 2001, Dechant *et al.* 2003b). Vegetation structure rather than species composition is thought to be important in nest site selection (Dorio and Grewe 1979, Patterson and Best 1996, Dechant *et al.* 2003b). Several studies have examined nesting habitat preferences of upland sandpipers within its breeding range in the United States (Dechant *et al.* 2003b). Comparatively few studies have been conducted in Canada.

Kantrud and Higgins (1992) summarized the characteristics of upland sandpiper nests found in North and South Dakota, Montana and southern Manitoba during 1963 to 1991. Most nests (366) were located in native prairie; 58 nests were found in seeded grasslands, and 10 in stubble and fallow (Kantrud and Higgins 1992). In terms of land use, 219 nests were located in grazed pastures, 179 in idle or ungrazed grasslands, 10 in hayfields and 37 in cropfields (Kantrud and Higgins 1992). Nests were most often placed in grass dominated sites with intermediate cover height (mean 26 cm) and density. The majority of nest sites had 100% visual obstruction at less than 15 cm, and effective cover height of less than 30 cm. In south-central North Dakota, upland sandpiper nests were most commonly found in areas with greater than 50% grass cover and less than 50% forb cover (Bowen and Kruse 1993). In Illinois, upland sandpipers most frequently nested in cover from 17 cm to 33 cm tall, in weedy fields that had been rotary mowed the previous summer or in old redtop (*Agrostis alba*)-timothy (*Phleum pretense*) meadows invaded with forbs and Kentucky bluegrass (Buhnerkempe and Westemeier 1988). Upland sandpipers tended to avoid nesting in fields with relatively uniform grass or legumes (Buhnerkempe and Westemeier 1988). In Central Wisconsin, Ailes (1980) found that upland sandpipers avoided nesting in heavily grazed grasslands or small-grain agriculture. Most nests were observed in hayfields or idle fields with 54% of nests located in vegetation cover 25 cm to 40 cm tall (Ailes 1980). Grasslands in this study were dominated by Kentucky bluegrass, quackgrass (*Elytrigia repens*), timothy and smooth brome. Of 15 nests in central Minnesota, the majority were in old fields (73%), 20% in pastures and 7% in a sedge-grass meadow (Dorio and Grewe 1979). Most nests were in vegetation 22.5 cm to 35.0 cm tall (Dorio 1977). In Saskatchewan, upland sandpipers most commonly nested in areas with tall, dense vegetation greater than 15 cm tall (Colwell and Oring 1990).

Forb cover may be an important characteristic of nesting habitat as several studies have documented the tendency of upland sandpipers to nest in areas with moderate amounts of forbs (Buhnerkempe and Westemeier 1988, Dechant *et al.* 2003b). The proximity of nest sites to suitable loafing and foraging habitats and the availability of display perches (such as fence posts, rock piles or tree stumps) are also important factors (Buhnerkempe and Westemeier 1988, Dechant *et al.* 2003b).

3.3.3 Brood Rearing Habitat

As with nesting, a range of habitats are used during the brood rearing period (Dechant *et al.* 2003b). Bolster (1990) noted a movement of broods from pastures to alfalfa fields; alfalfa and small-grain fields with vegetation heights less than 27 cm tall were used more often than expected during brood rearing. In Illinois, Buhnerkempe and Westemeier (1988) observed broods in wheat stubble, recently hayed legumes, old redtop and moderately grazed pastures. Broods used open, weedy habitats with short (less than 20 cm) vegetation (Buhnerkempe and Westemeier 1988). Openness and low vertical cover are thought to facilitate movement and foraging by chicks (Buhnerkempe and Westemeier 1988). In Wisconsin, Ailes (1980) reported that most upland sandpiper adults and broods moved to heavily grazed pastures during the brood rearing period (late June and July). Of the grazed fields used for foraging during brood rearing, 65% of fields were heavily grazed with vegetation heights less than 10 cm (Ailes 1976, 1980).

3.3.4 Foraging Habitat

In general, upland sandpipers prefer areas with short vegetation for foraging, potentially due to improved visibility and increased foraging efficiency (Dorio and Grewe 1979, Houston and Bowen 2001, Dechant *et al.* 2003b). In central Minnesota, Dorio and Grewe (1979) reported that upland sandpiper young and adults moved from denser nesting cover to forage in areas of "blow outs" and heavily grazed pastures, with vegetation less than 10 cm tall. The majority (54%) of feeding observations during incubation and brood rearing were in heavily grazed pastures (Dorio and Grewe 1979). Sedge-grass meadows were used during May until vegetation heights exceeded 30.0 cm tall (Dorio and Grewe 1979). Similarly, out of 1,116 feeding observations in central Wisconsin, the majority (66%) were in grazed pastures, 13% in ungrazed pastures, 11% in hayfields, 6% in cropland, and 3% in plowed fields (Ailes 1980). The majority (68%) of grazed pastures used for foraging were heavily grazed with vegetation heights of 0 to 10 cm.

3.3.5 Area Requirements

Upland sandpipers are considered highly sensitive to habitat fragmentation as their abundance has been positively correlated with field or patch size (Vickery *et al.* 1994, Helzer and Jelinski 1999, Walk and Warner 1999). Minimum area requirements of 50 ha to 61 ha (Helzer and Jelinski 1999), 65 ha (Walk and Warner 1999) and 200 ha (Vickery *et al.* 1994) have been reported for upland sandpipers in Nebraska, Illinois and Maine, respectively. It is recommended that habitat patches at least 100 ha in size (preferably 200 ha) and less than 1 km apart are retained and appropriately managed to provide sufficient habitat heterogeneity for upland sandpipers and other grassland species and to reduce edge effects (Herkert 1994, Vickery *et al.* 1994, Walk and Warner 1999). Habitat patches with high amounts of interior area are preferable as studies have shown that nest predation rates are higher in edge habitats (Johnson and Temple 1990).

4 SPRAGUE'S PIPIT

4.1 Background

Sprague's pipits, a songbird that is closely associated with native prairie, reach their highest continental abundance in southeastern Alberta (Prescott 1997). Although rarely seen, Sprague's pipits are best detected by the males' distinctive high pitched, descending flight song.

Sprague's pipits breed primarily in native grasslands of the Canadian prairies and the northern Great Plains (Prescott 1997, Robbins and Dale 1999). This species is at the northwest corner of its breeding range in Alberta where it breeds most commonly in the Grassland Natural Region and sporadically in the Central Parkland Region (Semenchuk 1992). Within Canada its breeding range extends west from the foothills of the Rocky Mountains across southern and central Alberta through central and southern Saskatchewan to west-central and southern Manitoba (Robbins and Dale 1999). A single confirmed breeding record was documented in south-central British Columbia (McConnell *et al.* 1993). In the United States its breeding range extends east from Montana through North Dakota, north and central South Dakota and into northwestern Minnesota (Prescott1997, Robbins and Dale 1999). Sprague's pipits winter in the southern United States and northern Mexico (Prescott 1997, Robbins and Dale 1999).

Like long-billed curlews and upland sandpipers, Sprague's pipits have experienced population declines or extirpations throughout its breeding range (Robbins and Dale 1999). Rapid population declines have been reported over much of its breeding range over the past 30 years

(Prescott 1997). North American Breeding Bird Survey trends indicate respective Canadian and continental population declines of 7% and 5% per year between 1966 and 2002 (Sauer *et al.* 2003). Declines of approximately 8% per year were recorded in Alberta over the same period (Sauer *et al.* 2003). Rapid population declines prompted its designation as “Threatened” in Canada in 1999 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2002b). Its status was re-examined and confirmed in May 2000 (COSEWIC 2002b). In Alberta, Sprague’s pipits are considered “Sensitive” at the general status level (SRD 2001a) and were recommended in 2000 as a “Species of Special Concern” under Alberta’s *Wildlife Act* (ESCC 2000).

The continuing loss, fragmentation or degradation of native prairie habitats is considered the most significant limiting factor to Sprague’s pipit populations throughout most of its range (Prescott 1997, Prescott and Davis 1999). Conversion of native prairie to cropland, intensive grazing and encroachment of woody vegetation due to reduced fire frequency are factors that can degrade or eliminate suitable pipit habitat (Prescott and Davis 1999).

4.2 Ecology

Sprague’s pipits arrive on breeding grounds in Alberta in late April to mid-May (Prescott 1997). Males have a distinctive flight display during the breeding period which often lasts over thirty minutes (Robbins and Dale 1999). Sprague’s pipits have defined breeding territories that are used for both nesting and feeding (Robbins and Dale 1999). Nest building usually begins in early to mid-May (Robbins and Dale 1999). Egg laying initiation dates range from the second week of May to the third week of July (Maher 1973, Robbins and Dale 1999). A clutch size of four or five eggs is typical (Prescott 1997). Females are primarily responsible for incubation and tending to the chicks (Prescott 1997). Eggs are usually incubated from 13 to 14 days (Robbins and Dale 1999). Newly hatched chicks (nestlings) are altricial, meaning their eyes are closed and they have little or no down and are reliant on being fed by the parents (Robbins and Dale 1999). Young leave the nest 9 to 12 days after hatching (Maher 1973), with fledging dates ranging from mid June to late August in Saskatchewan (Robbins and Dale 1999). Sprague’s pipits may raise two broods in a season, although the frequency of renesting or second nesting is thought to be fairly low (Sutter *et al.* 1996, Robbins and Dale 1999).

In Saskatchewan, flocks of adults and immatures begin to form in mid-July; flock sizes increase toward the end of August and beginning of September prior to migration (Robbins and Dale 1999). Most birds depart for wintering grounds in mid-September although Sprague’s pipits have been recorded in Saskatchewan as late as the first week of October (Prescott 1997).

4.2.1 Diet

Sprague’s pipits are almost entirely insectivorous (Maher 1979, Robbins and Dale 1999). The type of insects consumed varies over the breeding season. Maher (1974) examined food habitats of Sprague’s pipits in mixedgrass prairie of southwestern Saskatchewan during 4 summers. Maher (1974) found that beetles comprised more than 40% of the adult diet in May, whereas grasshoppers increased from 4% of the diet in May to 91% in September (Maher 1974). Seeds comprised less than 3% of the adult diet (Maher 1974). Nestlings also consumed a significant proportion of grasshoppers as well as lesser amounts of lepidopteran larvae, homopterans (leaf hoppers), spiders and hymenopterans (Maher 1974, 1979).

4.2.2 Predators

Predation can have a significant impact on Sprague's pipit nesting success (Prescott 1997). In Saskatchewan, predation was responsible for up to 69% of all Sprague's pipit nest losses (Maher 1973). In this study, 53% and 42% of nests survived the incubation and nestling periods, respectively (Maher 1973). Mammalian predators such as mice (*Peromyscus* spp.), ground squirrels (*Spermophilus* spp.), weasels, badgers, coyotes, red fox, raccoon, and skunks often account for a significant proportion of nest losses among grassland nesting birds (Patterson and Best 1996, Sutter 1997). Avian predators that target adults and young birds include various species of raptor as described for long-billed curlews and upland sandpipers. Nest productivity may also be reduced by brown-headed cowbirds which are known to parasitize (*i.e.,* lay their eggs in) pipit nests (Robbins and Dale 1999, Davis and Sealy 2000).

4.3 Habitat Requirements

4.3.1 General

Sprague's pipits are primarily found in well drained, open, fescue, dry mixedgrass and mixedgrass native prairie habitats (Prescott 1997, Robbins and Dale 1999). Numerous studies have found that Sprague's pipits tend to prefer native prairie habitats and show an aversion to seeded pasture, hayfields and croplands (Owens and Myres 1973, Wilson and Belcher 1989, Dale 1992, Prescott and Bilyk 1996, Prescott and Murphy 1996, Madden 1996, Davis and Duncan 1999, Davis *et al.* 1999, Madden *et al.* 2000). This trend has been confirmed in fescue prairie in the Hand Hills of southern Alberta where Sprague's pipits were significantly more abundant in native prairie than in cultivated lands (Owens and Myres 1973). In a more recent survey of the Southern Prairie Biome of Alberta, Prescott and Bilyk (1996) observed Sprague's pipits in 63% of native mixedgrass prairie sites (n=27) and 44.4% of fescue prairie sites (n=18). Sprague's pipits were only found in one seeded pasture site (n=16) and were not present in cropland or seeded hayfields (Prescott and Bilyk 1996). Similarly, Prescott and Wagner (1996) found that Sprague's pipits were significantly more common in native fescue or mixedgrass prairie than in seeded pasture near Brooks, Alberta. In southern Saskatchewan, Davis *et al.* (1999) found that Sprague's pipits were more common in fescue or mixedgrass prairie than in hayland or cropland. Sprague's pipits are also usually absent or less frequent in perennial dense nesting cover or Permanent Cover Program (PCP) sites in the Canadian prairies. During a recent evaluation of Agriculture Canada's PCP, McMaster and Davis (2001) reported that Sprague's pipits were infrequently detected in PCP sites in Alberta, Manitoba and Saskatchewan. PCP sites were comprised of a combination of either wheatgrass (*Agropyron* spp.), brome (*Bromus* spp.), alfalfa (*Medicago* spp.) or crested wheatgrass (*Agropyron pectiniforme*).

In general, vegetation structure is considered more important than plant species composition in determining Sprague's pipit habitat associations (Dechant *et al.* 2003c). Despite their preference for native prairie, Sprague's pipits have not been associated with specific plant species. Sprague's pipit preference for native prairie is thought to be due to the inherent structural heterogeneity of these habitats (Prescott 1997). Sprague's pipits tend to avoid tall vegetation or deep litter and usually occur in areas with intermediate vegetation height and density and moderate to high grass to forb ratios (Prescott and Murphy 1996, Prescott 1997, Madden *et al.* 2000, Dechant *et al.* 2003c). Sprague's pipits have been positively associated with moderate to high grass cover (33 to 53%), maximum vegetation heights of 28 cm, and litter depths of 1.2 cm to 3.1 cm (Dale 1983, Hooper and Pitt 1996, Madden 1996, Sutter 1996, Schneider 1998, Madden *et al.* 2000). Sprague's pipits also typically occur in areas with low shrub cover (Dechant *et al.* 2003c). Studies in North Dakota and southern Saskatchewan have found a negative association of Sprague's pipits with woody vegetation (Faanes 1983), shrubs 20 cm to 100 cm tall (Anstey *et al.* 1995) and density of low growing shrubs (Schneider 1998), as well as a positive association with low visual obstruction (Madden 1996, Madden *et al.* 2000). Madden *et al.* (2000) reported that Sprague's pipits in mixedgrass prairie in North Dakota were most common at visual obstruction readings of less than 8 cm.

The habitat suitability index (HSI) model for Sprague's pipits in the Milk River Basin included three, equally weighted variables: percent native grass; percent tree and shrub cover; and distance from riparian areas (Landry 2004). According to this model, areas comprised of greater than 25% native grassland, less than 15% shrub cover and located away from riparian areas were rated as highly suitable Sprague's pipit habitat. The HSI model was limited by the difficulty of modeling micro-habitat requirements such as grass height and density.

4.3.2 Nesting Habitat

Sprague's pipits construct nests on the ground, usually at the base of dense clumps of grass in open native prairie (Robbins and Dale 1999). In southwestern Saskatchewan, Sutter (1997) found that pipits preferred to nest in sites with dense, grassy, and relatively tall vegetation with low forb density and little bare ground in comparison to random sites. These characteristics are thought to offer protection from predation as well as reduced heat stress (Sutter 1997). Average, maximum vegetation height at 47 nests was approximately 28 cm; litter depth averaged 2.4 cm (Sutter 1997). Most nests were either completely or partially domed with a grass canopy comprised most often of northern wheatgrass (*Agropyron dasystachyum*) (the dominant grass at the study site).

4.3.3 Foraging Habitat

Throughout the year Sprague's pipits forage on the ground in open grassland habitats (Robbins and Dale 1999). Foraging occurs within the breeding territory.

4.3.4 Area Requirements

Area sensitivity is a topic that requires additional research in the Milk River Basin. Prescott and Davis (1999) suggest that areas of suitable habitat should be greater than 150 ha in size in order to be attractive as breeding sites for Sprague's pipits. In Saskatchewan, Sprague's pipits were found to require a minimum area of 190 ha (Saskatchewan Wetland Conservation Corporation (SWCC) 1997). Patch size may have an impact on rates of brown-headed cowbird parasitism. In Manitoba, brown-headed cowbird brood parasitism was higher on smaller tracts of land (22 ha) in comparison to larger habitat patches (64 ha) (Davis and Sealy 2000).

5 BAIRD'S SPARROW

5.1 Background

The Baird's sparrow is another cryptic songbird whose breeding range, like that of the Sprague's pipit is confined to the southern grassland regions of the Canadian prairies and the adjoining states to the south.

Within Alberta, Baird's sparrows breed most commonly south of Stettler and east of the Red Deer River with an extension west to the Calgary Area (Semenchuk 1992). The main Baird's sparrow breeding range extends from the southern regions of Alberta and Saskatchewan and the southwest portion of Manitoba, south to central and eastern Montana, and east to North Dakota and north-western and north-central South Dakota (Green *et al.* 2002). Baird's sparrows winter in the extreme southern United States (Arizona, Texas and New Mexico) into north-central Mexico (Green *et al.* 2002). Contraction of its breeding range has been reported in Minnesota and southeastern Manitoba (Green *et al.* 2002).

As with Sprague's pipits, there is limited population trend information available for Baird's sparrows in Alberta and an accurate estimate of population size is unavailable (Green *et al.* 2002). In Saskatchewan, the 1994 estimated population of singing males was 960,000 (Davis *et al.* 1996). Concern over apparent declines throughout its range, and its apparent preference for native prairie habitats prompted its designation as "Sensitive" in Alberta at the general status level (SRD 2001a). Baird's sparrows were designated as "Threatened" in Canada in 1989 by COSEWIC. However, due to research which revealed Baird's sparrows were more widespread, abundant and more adaptable to habitat changes than previously thought, its status was re-examined and it was de-listed "Not at Risk" in April 1996 (COSEWIC 2002c). Baird's sparrow populations are thought to have declined in relation to pre-settlement abundance, however, on a continental scale, suspected declines are not statistically significant, and are less than for the Sprague's pipit (Sauer *et al.* 2003).

As with the previous species discussed, Baird's sparrow populations are vulnerable to habitat loss, degradation or fragmentation (Davis and Sealy 1998, Green *et al.* 2002). Conversion of native prairie to cropland and exotic vegetation, invasion of native prairie by exotic plants, shrub encroachment due to fire suppression, and inappropriate range management are factors that contribute to habitat degradation or fragmentation (Owens and Myres 1973, Goosen *et al.* 1993, Green *et al.* 2002).

5.2 Ecology

Baird's sparrows are considered partially nomadic, due to significant spatial shifts in population densities from one year to the next (Green *et al.* 2002). This behaviour is thought to be an evolved response to the fluctuating spatial and temporal habitat conditions that would have been created by historic fire, drought or bison movements and grazing patterns (Green *et al.* 2002). Baird's sparrows usually arrive on breeding grounds in Alberta in mid-May (Semenchuk 1992**,** Green *et al.* 2002). Females often arrive up to one week after males with pair bonds forming after breeding territories have been established (Green *et al.* 2002). Nest building usually begins by the third week of May with egg laying initiated by late May to early June (Davis and Sealy 1998, Green *et al.* 2002). Usually, 4 to 5 eggs are laid (Davis and Sealy 1998, Green *et al.* 2002). Females incubate the eggs for a period of 11 to 12 days (Green *et al.* 2002). Normally one brood is reared per season; however, confirmed double broods have been documented in southwestern Manitoba (Davis and Sealy 1998). Second clutches were initiated in mid to late July in Manitoba (Davis and Sealy 1998). Like Sprague's pipit young, chicks are altricial, relying on the parents for food. Young fledge and leave the nest 8 to 11 days after hatching and are able to take short flights by 13 days old; newly fledged young remain in the parent's territory until 19 days old (Davis and Sealy 1998, Green *et al.* 2002). Baird's sparrows depart for wintering grounds from mid-September to October (Maher 1973, Dechant *et al.* 2003d).

5.2.1 Diet

During the breeding season, the Baird's sparrow diet consists mainly of insects including beetles (Coleoptera), grasshoppers (Orthoptera), and caterpillars (Lepidoptera larvae) (Green *et al.* 2002). Various grass and weed seeds and waste grains are also consumed (Green *et al.* 2002). Maher (1979) found that Baird's sparrow nestling diets in southwestern Saskatchewan were comprised mostly of grasshoppers and spiders.

5.2.2 Predators

As with Sprague's pipits, nest predation is the primary cause of nest failure for Baird's sparrows (Green *et al.* 2002). Predators destroyed 39% of 74 nests in southwestern Manitoba (Davis and Sealy 1998), 63% of 167 nests in southern Saskatchewan, and 37% of 52 nests in north-central Montana (Green *et al.* 2002). Baird's sparrow eggs and young are susceptible to a similar suite of predators as are Sprague's pipits (See Section 4.2.2). Nest losses in southwestern Alberta and Manitoba have been attributed to striped skunks, thirteen-lined ground squirrels and Richardson's ground squirrels (Mahon 1995, Davis and Sealy 1998). Northern harriers and merlins are known predators of young birds (Green *et al.* 2002). Cowbird brood parasitism is another significant cause of reduced Baird's sparrow productivity (Green *et al.* 2002). Cowbirds parasitized 36% of 74 nests in Manitoba (Davis and Sealy 1998), and 21% of 182 nests in Saskatchewan (Green *et al.* 2002).

5.3 <u>Habitat Requirements</u>

5.3.1 General

Baird's sparrows breed in mixedgrass and fescue prairies with scattered low shrubs (Green *et al.* 2002). Although previously thought to be exclusively associated with native prairie habitats, recent studies have found that Baird's sparrows do occur in modified grasslands, seeded pastures and hayfields with habitat structure components resembling native prairie (Sutter and Brigham 1998, Davis *et al.* 1999, Green *et al.* 2002, Dechant *et al.* 2003d). Baird's sparrows tend to avoid or occur in low densities in cropland (De Smet and Conrad 1991, Davis *et al.* 1996, Davis *et al.* 1999, McMaster and Davis 2001). Actively cultivated lands are considered unsuitable, unproductive habitats (Green *et al.* 2002).

In the Hand Hills of southern Alberta, Owens and Myres (1973), found that Baird's sparrows were significantly more common in native fescue grasslands than in cultivated lands. In the

Southern Prairie Biome of Alberta, Baird's sparrows were most common in fescue prairie and to a lesser extent in native mixedgrass, seeded pastures and silver sagebrush flats (Prescott and Bilyk 1996). Baird's sparrows were only observed in 8.3% of hayfield sites and were absent from cropland (Prescott and Bilyk 1996). In southwestern Alberta, Baird's sparrows in the Milk River Ridge area were found to breed in sites dominated by either rough fescue or crested-wheatgrass with similar vegetation structure (Mahon 1995). In Saskatchewan, Baird's sparrows were most common in the moist –mixed grassland ecoregion and occurred as frequently in hayland as in native and seeded pastures, but were significantly less common in cropland (Davis *et al.* 1999). Similarly, Davis *et al.* (1996), Sutter and Brigham (1998) and Davis and Duncan (1999) reported that Baird's sparrows in southern Saskatchewan were as frequent in crested wheatgrass pastures as in native prairie habitats. Although hayland or seeded pasture dominated by narrow-leaved (2 mm to 4 mm) graminoids such as crested wheatgrass are readily used by Baird's sparrows, various studies have found that this species avoid stands of broad-leaved (5 mm to 10 mm) graminoids such as smooth brome (Dale 1992, Anstey *et al.* 1995, Mahon 1995, Madden 1996).

Like Sprague's pipits, Baird's sparrows are thought to be strongly influenced by vegetation structure rather than plant species composition (Mahon 1995, Davis *et al.* 1996, Dechant *et al.* 2003d). Baird's sparrows have been positively associated with grasslands dominated by native or narrow-leaved exotic grasses, shrub cover of less than 20%, litter depths of 0.1 cm to 4 cm and average grass heights of 10 cm to 30 cm (Dale 1983, Sousa and McDonal 1983, Madden *et al.* 2000, Green *et al.* 2002). As with Sprague's pipits, Baird's sparrows tend to avoid grasslands with high amounts of shrubby or woody cover (Green *et al.* 2002, Dechant *et al.* 2003d). In mixedgrass prairie of northwest North Dakota, Baird's sparrows occurred more commonly in areas with more than 42% grass cover and more than 35% forb cover and with visual obstruction readings of less than 15 cm (Madden *et al.* 2000).

5.3.2 Nesting Habitat

Like the Sprague's pipit, Baird's sparrows are ground nesters, often nesting between or beneath clumps of grass. In comparison to random sites, nests in mixedgrass prairie in southern Saskatchewan were found in areas with less bare ground, taller vegetation (average height of 28.5 cm versus 20.1 cm) and increased litter depth (1.1 cm versus 0.5 cm) (Green *et al.* 2002). Nest sites were also characterized by a greater density of standing dead vegetation and lower density of live grasses up to 10 cm high (Green *et al.* 2002). In the Milk River Ridge area of Alberta, Mahon (1995) observed that Baird's sparrows consistently chose breeding territories with high forb cover and high densities of low and middle canopy grasses (less than 20 cm) during June and July. Areas with suitable perch sites such as tall grass clumps or tall fobs and that offered sufficient cover for adults and nests were preferred (Mahon 1995). Baird's sparrows tended to avoid areas with high shrub cover, high litter depth and vegetation heights exceeding 20 cm (Mahon 1995).

5.3.3 Foraging Habitat

Baird's sparrows forage mostly on the ground in between grass clumps, avoiding open areas (Green *et al.* 2002). Areas with deep litter, dense standing dead vegetation or dense grass cover may impede foraging efficiency by Baird's sparrows (Mahon 1995).

5.3.4 Area Requirements

In Saskatchewan, Baird's sparrow abundance and occurrence was positively associated with patch size of native prairie (Green *et al.* 2002). Baird's sparrows were most common in habitat patches greater than 58 ha (Green *et al.* 2002). Similarly, Baird's sparrows were positively correlated with the total area of seeded fields in Saskatchewan, and occurred more frequently in PCP lands surrounded by grasslands versus cropland, wetland, woodland or human residences (McMaster and Davis 2001). Like Sprague's pipits, Baird's sparrows may also be susceptible to higher rates of nest predation or cowbird parasitism in smaller habitat patches (Davis and Sealy 1998). In Saskatchewan, the frequency of cowbird parasitism was greatest among Baird's sparrow nests in native pastures that were less than 256 ha (Green *et al.* 2002). High rates of Baird's sparrow brood parasitism were found in Manitoba in native and seeded habitat patches 20 ha to 64 ha in size (Davis and Sealy 1998).

6 GRAZING AND GRASSLAND BIRDS

Endemic grassland birds evolved in a dynamic landscape influenced by fire, drought and vast herds of bison grazers and other wild herbivores. These factors created a diversity of habitat conditions stimulating a range of adaptations among birds to differing degrees of disturbance. Correspondingly, grassland birds can be arranged along a gradient of increasing vegetation cover and decreasing tolerance to disturbance (Knopf 1996a) (Figure III-1). At one extreme of the spectrum are species like the mountain plover that favour extremely short vegetation and high amounts of grazing disturbance. At the other end of the continuum are species like Sprague's pipits and Baird's sparrows which prefer greater amounts of vegetation cover and decrease under heavy grazing. Long-billed curlews and upland sandpipers fall in between.

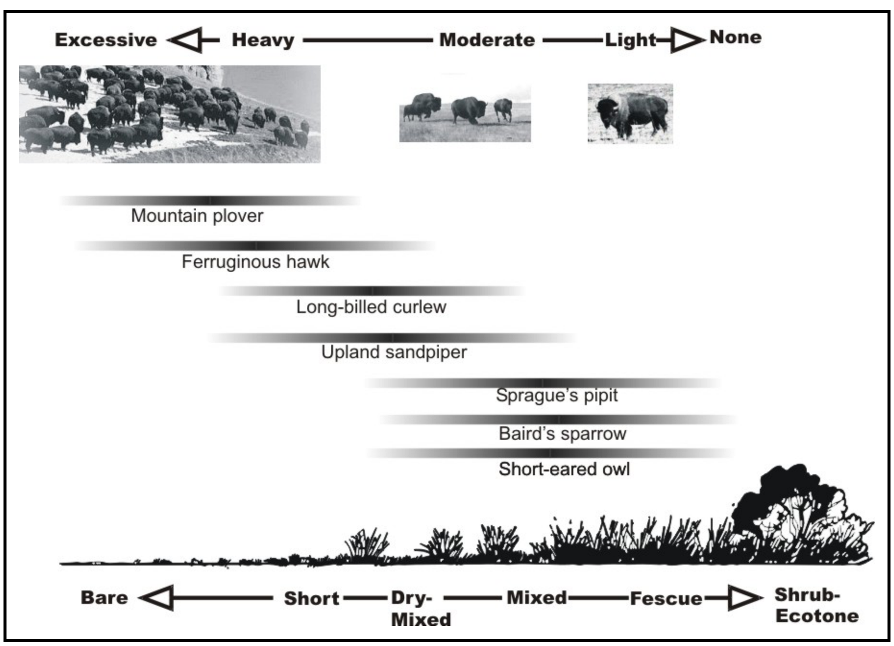

Figure III-1: Distribution of Grassland Birds in relation to Grassland Type and Historical Grazing Pressure (adapted from Knopf 1996a)

Grazing affects grassland habitat characteristics by influencing vegetation species composition and productivity and by changing horizontal and vertical vegetation structure (*e.g.,* height, density and litter cover) (Severson and Urness 1994). These characteristics influence the suitability of an area to birds by affecting key parameters such as availability of display perches, nesting or brood rearing cover or prey diversity or abundance. To a lesser extent, large grazers may also impact grassland bird productivity due to direct trampling of nests.

The response of grassland birds to grazing pressure varies depending on soil type, moisture regime and vegetation type (Knopf 1996b). For example, species that usually occur in medium height mixedgrass prairie typically respond negatively to heavy grazing in arid grasslands but respond favourably to increased grazing intensity in mesic (*e.g.,* tallgrass) prairie. Therefore, although the habitat requirements of birds may exist naturally at one location, a differential degree of disturbance may be required at other locations to establish similar structural or species composition parameters (Knopf 1996b). Even at the same location, birds may exhibit a varying response to grazing in relation to variation in seasonal precipitation. It is therefore important to set stocking rates and grazing frequency in accordance with local ecological conditions and to adjust stocking rates during drought conditions.

Livestock grazing can be used to create habitat conditions that are suitable for a diverse suite of grassland birds, such as those considered in this report. Appropriately managed, grazing can stimulate habitat heterogeneity, reduce dense accumulation of litter or residual vegetation, and reduce encroachment of shrubs or woody species. These properties are considered beneficial to long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows. In the absence of grazing, other mechanisms such as prescribed burns or periodic mowing are required to create similar conditions. Section 8 includes recommendations for appropriate burn or mowing strategies to enhance habitat for curlews, upland sandpipers, Sprague's pipits and Baird's sparrows.

The following sub-sections discuss in greater depth the response of Long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows to grazing. Overall, these species have similar habitat requirements and respond favourably to light to moderate grazing, depending on local site conditions. Unlike Sprague's pipits and Baird's sparrows, long-billed curlews and upland sandpipers require larger areas of shorter vegetation during the breeding season, making them more reliant on sustained patches of heavier grazing.

6.1 Long-billed Curlew Response to Grazing

Overall, grazing is considered beneficial for creating suitable habitat for long-billed curlews (Dechant *et al.* 2003a). The effects of grazing on curlew habitats vary depending on conditions such as soil type, vegetation structure and moisture regime (De Smet 1992, Hill 1998, Dechant *et al.* 2003a). Based on a review of studies conducted in the Northern Great Plains, Kantrud and Kologiski (1982) found that curlews generally preferred lightly grazed aridic soils and heavily grazed moister soils. In Alberta, breeding densities of curlews are often highest in moderately grazed mixedgrass prairie with sandy loam soils (De Smet 1992). Moderate livestock grazing is thought to be compatible with maintaining the variable vegetation structure required by curlews throughout the breeding season (Hill 1998). Moderate grazing usually promotes patchy vegetation structure, creating areas of shorter cover used by curlews for nesting and foraging, and retaining areas of denser, taller vegetation used during brood rearing (Hill 1998, Dechant *et al.* 2003a). Patches of open ground and shorter grass are also important for predator detection and adult and chick mobility (Pampush and Anthony 1993, Dugger and Dugger 2002).

Although several studies have assessed curlew response to grazing in the Northern Great Plains region of the United States (Bicak *et al.* 1982, Kantrud and Kologiski 1982, Cochran and Anderson 1987, Bock *et al.* 1993), few studies have been conducted in the Canadian prairies (Prescott *et al.* 1993, Prescott and Wagner 1996). In southern Alberta, Prescott and Wagner (1996) found that long-billed curlews were most common in continuously grazed and early-season (April to mid-June) grazed mixedgrass prairie. Curlews were present in only a few seeded pasture sites and did not occur in areas where grazing was deferred until after mid-June, when pairs had already established territories (Prescott and Wagner 1996). Grazing systems that created reduced vegetation height and density early in the spring during the prelaying and laying periods were similarly considered beneficial to curlews in Idaho (Bicak *et al.* 1982, Redmond and Jenni 1982). Removal of tall, dense residual vegetation before the pre-laying period allowed adults to stay in their territory to forage (Remond and Jenni 1986).

Livestock grazing not only has the potential to alter vegetation structure, but may also impact curlew nesting success. In Wyoming, Cochran and Anderson (1987) found that nests in areas that were grazed during the nesting period had lower hatching success than nests in ungrazed areas. Redmond and Jenni (1986) noted that of 119 nests in western Idaho, 4.2% of nests were abandoned or lost due to livestock disturbance. In general, livestock trampling of nests is not likely to be a significant concern unless stocking rates are extremely high during the nesting season (Dugger and Dugger 2002). Other factors that influence the likelihood of nest abandonment or destruction include the length of incubation prior to livestock introduction as well as the duration and frequency of livestock disturbance (De Smet 1992).

6.2 Upland Sandpiper Response to Grazing

As with long-billed curlews, a grazing system that promotes patches of high, moderate and lighter use is also considered beneficial for meeting the diverse habitat requirements of upland sandpipers. Shorter vegetation in more heavily grazed areas provide upland sandpipers with suitable foraging sites, while patches with intermediate grazing intensity and short to medium vegetation may be suitable for brood rearing. Less heavily used areas with taller vegetation may provide suitable cover for nesting (Dechant *et al.* 2003b). Like long-billed curlews, upland sandpipers, vary in their response to grazing in different regions depending on vegetation type, moisture regime and soil condition (Saab *et al.* 1995). Upland sandpipers responded positively to moderate grazing in areas with moister soils in the Northern Great Plains (Kantrud and Kologiski 1982) and to moderate and heavy grazing in tallgrass prairie in Missouri (Skinner 1975). In mixedgrass prairie in Saskatchewan, Dale (1984) found that upland sandpipers nested only in grazed pastures and were not observed in ungrazed areas. Upland sandpipers were only observed on deferred-grazed (grazed after July 15) mixedgrass prairie in southern Alberta (Prescott and Wagner 1996). None were present on continuous or early season grazed prairie or in seeded pastures (Prescott and Wagner 1996).

Several studies have examined the effects of grazing on nest density or nesting success of upland sandpipers in mixedgrass prairie in south-central North Dakota (Kirsh and Higgins 1976, Messmer 1990, Bowen and Kruse 1993, Sedivec 1994). Bowen and Kruse (1993) found that upland sandpiper nest densities were lower in fields that were grazed during the nesting season (*i.e.,* season long, spring, or fall-and-spring grazing) than in ungrazed fields or fields with fall grazing. In central Wisconsin, Ailes (1980) reported that upland sandpipers did not nest in areas of heavy livestock grazing. Livestock trampling was identified as the primary cause of nest destruction in this study (Ailes 1980). Similarly, Kirsh and Higgins (1976) found that upland sandpiper nest success was lower on grazed land (48%) than on undisturbed grassland (71%) or previously burned grassland. Nesting success was also lower on grazed fields than on idle fields in the prairie pothole region of South Dakota, North Dakota, Montana and Manitoba (Kantrud and Higgins 1992). However, of 32% nest losses on grazed fields, only 1% were directly due to livestock disturbance (Kantrud and Higgins 1992). Contrary to the former studies, Messmer (1990) found that upland sandpiper nest density and nest success were higher under twice-over deferred and season-long grazing systems than on idle (ungrazed) pastures. Under the twice-over deferred rotation system, pastures were grazed twice per season with a two month rest in grazing (Messmer 1990). Of interest, Messmer (1990) noted that the average density of breeding sandpipers was highest on the short-duration grazing system where pastures were sequentially grazed for a week and then rested for a month from late May or early June until October (Messmer 1990). Sedivec (1994) similarly reported that upland sandpiper nesting density was significantly higher on grazed mixedgrass pastures than in idle grasslands.

6.3 Sprague's Pipit and Baird's Sparrow Response to Grazing

Sprague's pipits and Baird's sparrows appear to favour light to moderate grazing intensity through much of their range (Dechant *et al.* 2003c,d). As with the previous species, the effects of grazing intensity vary according to local environmental conditions (Bock *et al.* 1993, Saab *et al.* 1995, Robbins and Dale 1999). Moderate grazing may be tolerated by these species in mesic grasslands, however, lighter use is considered more appropriate in arid mixedgrass and dry mixedgrass prairies (Prescott 1997, Robbins and Dale 1999, Dechant *et al.* 2003d). Periodic grazing or other types of disturbances such as burning or mowing are considered particularly beneficial to Sprague's pipits and Baird's sparrows in areas with uniformly tall, dense vegetation and excessive litter accumulation (Madden 1996, Madden *et al.* 2000, Dechant *et al.* 2003c.d). Both species respond favourably to intermediate vegetation height and density and tend to avoid areas with dense, matted vegetation or litter build-up exceeding 4 cm (Dechant *et al.* 2003c,d). Several studies in fescue and mixedgrass prairie in Alberta and Saskatchewan have documented the similar tendency for Sprague's pipits and Baird's sparrows to respond negatively to heavy grazing and to occur more frequently in ungrazed or light to moderately grazed areas (Owens and Myres 1973, Maher 1979, Dale 1984, Anstey *et al.* 1995). Similar results have been reported for the Northern Great Plains states (Kantrud and Kologiski 1982) with the exception of a study in North Dakota which found that Sprague's pipits preferred both heavily and moderately grazed plots over lightly grazed plots in an area with higher grassland productivity (Kantrud 1981). Sprague's pipits and Baird's sparrows were associated with higher range condition scores (mean of approximately 53%, i.e., "good" condition) and were absent on pastures with range condition scores less than 20% (i.e., "poor" condition) in the grassland ecoregion of southern Saskatchewan (Wroe *et al.* 1988, Anstey *et al.* 1995). Similarly, Sprague's pipits were significantly more common in higher condition rangeland with low shrub cover in fescue grasslands of the Cypress Hills (Hull 2002).

A comparison of various grazing systems in mixedgrass prairie in southern Alberta found that Sprague's pipits were most common in early-season grazed native prairie (grazed before July 15) in 1993 and 1995 (Prescott *et al.* 1993, Prescott and Wagner 1996). Sprague's pipits varied in their response to continuous and deferred grazing (grazed after July 15) between years, but were consistently more common in managed native prairie than in seeded pastures (Prescott *et al.* 1993, Prescott and Wagner 1996). Baird's sparrows showed a preference for early-season grazed and deferred grazed prairie in 1993, however, they occurred with similar frequency in all grazing treatments in 1995 (including seeded pasture) (Prescott *et al.* 1993, Prescott and Wagner 1996). High spring rainfall and improved plant vigour in all treatments may have influenced the greater distribution of Baird's sparrows in 1995 (Prescott and Wagner 1996).

Few studies have examined the effects of various grazing systems or grazing intensities on the reproductive success of either Sprague's pipits or Baird's sparrows. These types of studies are complicated by the inherent difficulty of finding sufficient numbers of cryptic ground nests and determining the indirect influence of grazing on nesting success.

7 GRAZING SYSTEMS AND GRASSLAND BIRD HABITAT MANAGEMENT

Table III-8 provides an overview of five pertinent grazing systems and their potential positive and negative implications to long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows. A grazing system is a tool used to control the spatial distribution, timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003).

As discussed previously, the effects of each grazing system will vary depending on moisture regime, range site, vegetation type and stocking rates.

Table III-8 Grazing Systems and Grassland Bird Habitat Management

Grazing System	**Discussion**
Continuous (Season-long) Grazing	
Advantages:	Continuous grazing systems at light to moderate stocking rates may create suitable habitat conditions for the suite of species considered in this report if it promotes variable grazing pressure across the rangeland with a gradient of light to heavily used patches. Variably grazed patches help to create a heterogeneous habitat mosaic suitable for meeting the diverse cover requirements of a range of grassland nesting birds. Heavier grazed patches provide foraging habitat for upland sandpipers and long-billed curlews, while areas of less use provide suitable nesting cover for Sprague's pipits and Baird's sparrows. Continuous grazing in mixedgrass habitats in Alberta may be particularly beneficial for long-billed curlews (Prescott *et al.*1993, Prescott and Wagner 1996). Prescott *et al.* (1993) and Prescott and Wagner (1996) found that curlews preferentially used continuously grazed pastures in comparison to deferred grazed or seeded pastures near Brooks, Alberta. Continuous grazing, unlike deferred grazing, is capable of providing curlews with suitable foraging habitat (*i.e.,* patches of shorter, open vegetation) early in the season. More studies are needed thought to determine productivity of curlews in continuous grazing systems in the Milk River Basin.
Disadvantages:	Continuous grazing can be detrimental to grassland bird habitat if stocking rates are high, resulting in uniform reduction in vegetation or litter cover (Dechant *et al.* 2003b,c,d). Extensive removal of vegetation cover and litter reduces the available nesting cover for upland sandpipers, Sprague's pipits and Baird's sparrows and potentially eliminates suitable brood rearing habitat for long-billed curlews. The effects of heavy, continuous grazing are partially dependent on the size of continuously grazed pastures and the heterogeneity of the surrounding grassland landscape. Another negative effect of continuous heavy grazing is that it may result in increased trampling risks to nests (Kirsh and Higgins 1976, Ailes 1980, Cochran and Anderson 1987, Bowen and Kruse 1993). Under continuous grazing, defoliation occurs during the nesting period and no areas are rested.
Deferred Grazing	
Advantages:	Grazing that is deferred during the critical brood rearing and nesting periods (i.e., mid to late summer) is thought to promote higher nest success among most ground nesting birds (Holechek *et al.* 1982). Deferral minimizes loss of residual nesting cover early in the season and avoids trampling disturbance to nests. Deferred grazing also has benefits for improved range condition as native grasses are generally more sensitive to defoliation early in the growing season (Adams *et al.* 1991). Nesting success of upland nesting passerines in the Aspen Parkland of central Alberta was higher at the pasture level in paddocks that were grazed later in the season (July) than those grazed in late May or June (Prescott *et al*. 1997). Similarly, various studies in Wyoming, North Dakota and Wisconsin have correlated reduced nest density and reduced nesting success of upland sandpipers and long-billed curlews with occurrence of livestock grazing during the nesting period (Kirsh and Higgins 1976, Ailes 1980, Cochran and Anderson 1987, Bowen and Kruse 1993). Bowen and Kruse (1993) recommended delaying grazing until after nesting is underway in mid to late June to reduce potential impacts to upland sandpipers in mixedgrass prairie in North Dakota. In southern Alberta, Prescott and Wagner (1996) found that upland sandpipers were only present in deferred grazed pastures.

Grazing System	**Discussion**
Deferred Grazing Cont'd.	
Disadvantages:	The benefits of deferred grazing can be offset if heavy use occurs subsequent to deferral, diminishing brood rearing cover and reducing residual vegetation for the next nesting season (Holechek *et al.* 1982). Another possible negative effect of deferred grazing is that it may diminish the amount of suitable foraging habitat that is available to long-billed curlews early in the season. For example, in southern Alberta, no curlews were found on plots where grazing was deferred until after mid-June when pairs had already established territories (Prescott and Wagner 1996). The majority of curlews were either on early season (April to mid-June) grazed or continuously grazed plots (Prescott and Wagner 1996)
Complementary Grazing	
Advantages:	Complementary grazing, a form of deferred grazing, also promotes undisturbed residual nesting cover and limits disturbance to birds during nesting and brood-rearing. Deferred grazing of native prairie early in the season, as mentioned, can improve the health, productivity and sustainability of fescue and mixed grasslands. Based on the results of a six year study, Prescott and Wagner (1996) concluded that complementary grazing in combination with rotational grazing improved range condition, grass yields and litter reserves in mixedgrass prairie in southern Alberta. These improvements were noted to provide a mosaic of habitats suitable for a wide spectrum of upland nesting birds including Long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows.
Disadvantages:	The benefits of complementary grazing depend on whether existing cropland or hayland can be converted to seeded pasture. If seeded pasture is created by converting native prairie habitat, fewer benefits may be realized. Although long-billed curlews, upland sandpipers and Baird's sparrows have been found to utilize seeded pastures for either foraging, nesting or brood rearing, Sprague's pipits are significantly more abundant in native prairie habitats (Robbins and Dale 1999).
Rotational Grazing	
Advantages:	Rotational grazing systems are usually recommended as an effective grassland bird habitat management tool (Sedivec *et al.* 1991, Bowen and Kruse 1993, Prescott and Wagner 1996, Stanley *et al.* 1999). Rotational grazing systems allow pastures to be rested in a sequential fashion for either an entire season or part of a season (Holechek *et al.* 2003). This provides a mechanism to promote vegetation heterogeneity at a pasture level and allows areas to be free from livestock disturbance during the critical nesting or brood rearing periods. Rotational grazing systems, due to the requirement of additional fencing, have the added benefit of creating numerous perch sites for upland sandpipers (Houston and Bowen 2001). Rotational grazing systems have been promoted for long-billed curlews in Idaho (Bicak *et al.* 1982), for upland sandpipers and Baird's sparrows in North Dakota (Messmer 1990, Bowen and Kruse 1993, Sedivec 1994) and for Sprague's pipits in mixedgrass and fescue prairie in southern Alberta (Mahon 1995, Prescott and Wagner 1996).
Disadvantages:	Areas that are rested for periods of one year or greater may not offer suitable foraging habitat for long-billed curlews or upland sandpipers (Bicak *et al.* 1982). Grazing intensities greater than 50 percent utilization may diminish the benefits of rotational grazing leading to deteriorated range condition, removal of residual nesting or brood rearing cover, and uniform vegetation structure (Kobriger 1980, Holechek *et al.* 1982).

Grazing System	**Discussion**
Intensive Grazing	
Advantages:	Intensive grazing may be appropriate for creating suitable habitat conditions for long-billed curlews or upland sandpipers in mesic grasslands with higher productivity, or in seeded pastures (Skinner 1975, Kantrud and Kologiski 1982, Bolster 1990). In North Dakota, Messmer (1990) found the highest breeding densities of upland sandpipers in a short-duration grazing system in mixedgrass prairie in south-central North Dakota. Both long-billed curlews and upland sandpipers use heavier grazed areas for foraging (Dechant *et al.* 2003a,b).
Disadvantages:	Intensive grazing may be particularly harmful to Baird's sparrows and Sprague's pipits. Both species have consistently been shown to decline under heavy grazing pressure in mixedgrass and fescue prairie in Alberta and Saskatchewan (Owens and Myres 1973, Maher 1979, Dale 1984, Anstey *et al.* 1995). Heavy grazing may also reduce or eliminate suitable brood rearing and nesting habitat for long-billed curlews and upland sandpipers, respectively, particularly in arid mixedgrass regions (Dechant *et al.* 2003a,b). Kantrud (1981) noted an overall trend of reduced bird species diversity with increased grazing intensity in North Dakota. Ground nesting birds are also potentially vulnerable to increased rates of nest abandonment or trampling with increasing stocking rates (Hill 1998).

8 BENEFICIAL MANAGEMENT PRACTICE RECOMMENDATIONS

The following general land use and grazing recommendations offer a variety of means to protect or enhance grassland breeding bird habitat within the Milk River Basin and throughout the Grassland Natural Region of Alberta. Further research (Section 9) is required to improve our understanding of grassland bird response to various land use activities including grazing, particularly with respect to effects on productivity (nesting success), prey availability and habitat selection.

8.1 General Recommendations

Breeding Habitat Protection / Enhancement:

- Protect remaining tracts of native prairie from cultivation (Owens and Myres 1973, Goosen *et al.* 1993, Hill 1998, Saunders 2001, Dechant *et al.* 2003a,b,c,d,). Croplands, fallow and stubble fields do not provide suitable habitat for Sprague's pipits and are used less and considered less productive habitats for Baird's Sparrows, long-billed curlews and upland sandpipers (Dechant *et al.* 2003a,b,c,d).
- Encourage no-till or minimum tillage and organic farming practices (Lokemoen and Beiser 1997, Houston and Bowen 2001, Dechant *et al.* 2003a,b,c,d, Martin and Forsyth 2003). These practices help to reduce or avoid disturbance during the nesting season. Martin and Forsyth (2003) found an overall higher abundance of songbirds in minimum versus conventional tilled habitats in southern Alberta.
- Consider planting winter wheat as a crop alternative. Winter wheat fields require less disturbance in spring and early summer, minimizing possible disturbance to nests or broods that utilize cultivated fields. Winter wheat is usually seeded into standing stubble in late August or early September, and harvested early the following August (Fowler 2002).
- Delay haying or harvesting crops until late July or August after the peak nesting period to reduce potential losses of nests or young broods (Dale *et al.* 1997, Dechant *et al.* 2003a,b,c,d).
- Where practical, convert non-native uplands (*e.g.,* cropland, hayland or seeded pasture) to native vegetation (Dale *et al.* 1997, Dechant *et al.* 2003c). Give priority to restoring areas adjacent to high quality sites to counter the effects of habitat fragmentation (Dale *et al.* 1997).
- Control encroachment of broad-leaved exotic graminoids such as smooth brome or timothy grass (Phleum pretense) in native prairie habitats. Sprague's pipits and Baird's sparrows prefer habitats with narrow-leaf grasses and have been negatively associated with broad-leaved graminoids (Wilson and Belcher 1989, Dale 1992, Anstey *et al.* 1995).
- Promote habitat heterogeneity of grasslands by implementing controlled burns, grazing or haying treatments, allowing for sufficient rest periods (Dechant *et al.* 2003a,b,c,d). Provide a mosaic of vegetation heights and densities and variable grass to forb cover ratios to meet the

diverse habitat requirements of long-billed curlews and upland sandpipers over the course of the breeding season. Allow some areas to be undisturbed during the nesting season.

- Maintain sufficient patch sizes of open grassland (see Area Requirements) with minimal (i.e., less than 20%) shrub or woody species encroachment (Dechant *et al.* 2003a,b,c,d). Long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows all tend to avoid grasslands with high amounts of shrubby or woody cover.

Area Requirements:

- Protect large, contiguous blocks of native prairie and grassland habitats. Habitat fragmentation can cause patch-size, edge, and isolation effects that can negatively affect use or reproductive success of breeding birds (Johnson and Igl 2001). Several studies have shown that nest predation and nest parasitism rates are higher in edge habitats (Johnson and Temple 1990). Moreover, studies have found that grassland breeding bird species richness increases significantly with increasing patch size (Herkert 1994, Vickery *et al.* 1994).
- Where possible, manage and maintain habitat parcels of at least 100 ha (preferably 200 ha) in size to reduce edge effects, decrease nest predation, and provide sufficient habitat heterogeneity (Herkert 1994, Vickery *et al.* 1994, Houston and Bowen 2001). Blocks of habitat should be within 1 km of each other, and should be contiguous with grassy habitats such as pastures or hayfields (Herkert 1994, Vickery *et al.* 1994, Walk and Warner 1999).
- Consider patch shape and core area dimensions (Helzer and Jelinski 1999). Maintain or create grassland habitats with high interior area and minimized edge (*i.e.,* low perimeter to area ratio) (Helzer and Jelinski 1999). For example, irregularly shaped patches have higher perimeter to area ratios than circular or regular shaped patches (Helzer and Jelinski 1999). Helzer and Jelinski (1999) found that patch area and low perimeter-area ratios were positive predictors of grassland birch species richness.

Prescribed Burning or Mowing:

- In the absence of grazing, prescribed burning or mowing provide alternative management tools to control shrub or woody species encroachment, reduce dense litter build-up and create a mosaic of grasslands of different heights (Hull 2002, Dechant *et al.* 2003a,b,c,d). These factors are beneficial for creating suitable habitat for long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows (Dechant *et al.* 2003a,b,c,d). By improving structural heterogeneity, this form of management also promotes suitable habitat for a diversity of other grassland birds. It can also be used to improve forage quality and availability for livestock in highly productive, mesic grasslands. Burning or mowing treatments may not be appropriate or desirable in arid conditions where accumulation of litter or tall, dense residual vegetation is not a concern (Madden *et al.* 1999, Dechant *et al.* 2003d).
- The timing, spatial extent and distribution, and frequency of burns or mows are key considerations to minimize disturbance and avoid possible losses of eggs or young. Frequent, large scale burns can also decrease forb species diversity and reduce grassland nitrogen levels (Arenz and Joern 1996).
- Burning and mowing should be deferred until after the peak nesting season (from May 1 to the end of July) (Mahon 1995, Patterson and Best 1996, Dale *et al.* 1997, Dechant *et al.* 2003a,b,c,d). Where possible, delay mowing or burning into mid-August to minimize

possible nest or brood losses, particularly during years of delayed nesting such as years of inclement spring weather (Dale *et al.* 1997, Dechant *et al.* 2003d).

- Mow grasslands or cut hay on a rotational schedule whereby fields are mowed every second year at a delayed date (Dale *et al.* 1997). Alternatively, divide large hay fields in half, with each half mowed in alternate years (Dale *et al.* 1997). This will help minimize potential nest losses and provide adjacent protective cover for newly fledged young in mowed areas (Dale *et al.* 1997). Hay fields should not be idled for more than one year to remain suitable as breeding sites for Sprague's pipits or Baird's sparrows (Dale *et al.* 1997).
- Prescribed burning should also be conducted on a rotational basis, with recently burned patches adjacent to unburned or less recently burned areas. This will help to create patches with a variety of successional stages and vegetation heights (Renken and Dinsmore 1987, Johnson 1997, Madden *et al.* 1999, Dechant *et al.* 2003d). Herkert (1994) recommends burning 20% to 30% of grassland fragments less than 80 ha, to ensure that sufficient amounts of unburned area are left to provide nesting or brood-rearing cover.
- Burn intervals should correspond with the approximate historic fire return interval for the region (Madden *et al.* 1999). The estimated, historic fire return interval is 5 to 10 years for fescue prairie (Arno 1980, Wright and Bailey 1982), 6 years for northern mixedgrass prairie, and up to 25 years for dry, western mixedgrass prairie (Madden *et al.* 1999).
- Prescribed burns should be conducted either early in the season (March to early April) or late in the season (October to November) (Kirsh and Higgins 1976, Herkert 1994).

Pest Control:

- Reduce or avoid the use of organochlorine pesticides including carbamates, carbofurans and organophosphates (De Smet 1992, COSEWIC 2002a). The use of organochlorine pesticides have caused documented mortalities and other sublethal effects in long-billed curlews (Blus *et al*. 1985). More research is needed to determine the potential detrimental effects of pesticide use on upland sandpipers, Sprague's pipits and Baird's sparrows (Prescott and Davis 1999, Houston and Bowen 2001, Green *et al.* 2002). Pesticide use may adversely effect grassland bird breeding success due to direct chemical ingestion or reduction in invertebrate prey abundance (De Smet 1992, Prescott and Davis 1999).
- Encourage organic farming practices and promote grassland birds as natural pest control agents.

Disturbance – Human Activities and Development:

- Reduce human disturbance in breeding areas during the nesting period to avoid disturbing nesting birds or young broods (Dechant *et al.* 2003a). Long-billed curlews are considered particularly sensitive to human disturbance during the nesting and brood rearing periods (Dugger and Dugger 2002). Excessive off-road vehicle use, for example, can cause nest abandonment and disrupt brooding or shading of chicks by curlew adults (Dugger and Dugger 2002).
- Minimize road or industrial development in prime grassland bird breeding habitats to reduce habitat loss and fragmentation (Redmond and Jenni 1986, Hill 1998).

- Conduct pre-development spring wildlife surveys and abide by setback distances and timing restrictions recommended by SRD, Fish and Wildlife Division for human activities, including industrial development near to long-billed curlew and Sprague's pipit nest sites (SRD 2001b). SRD recommends a 200 m and a 100 m setback for high-impact industrial disturbance activities from long-billed curlew and Sprague's pipit nest sites, respectively, during the breeding season (April 15 to July 15) (SRD 2001b).

8.2 Grazing Recommendations

Livestock grazing can be used as a tool to manage for grasslands with diverse vegetation structure and species composition, suitable to a broad range of grassland birds. Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

Grazing systems that will benefit long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows should aim to:

- Create a mosaic of variably grazed patches across the landscape, with a gradation of heavy, moderate and lighter use;
- Leave at least one field or a portion of a field undisturbed during the peak nesting period (May to mid-July);
- Maintain shrub canopy cover at less than 20%; and
- Stimulate vegetation diversity with moderate grass to forb ratios, a mixture of tall, medium and short canopy grass species and scattered tall forbs (Mahon 1995).

In order to meet these objectives, the following grazing recommendations apply:

- Avoid intensive, high stocking rate grazing systems and discourage uniform utilization of pastures (Dechant *et al.* 2003a,b,c,d). Uniform heavy use diminishes nesting or brood rearing cover and may result in greater disturbance to nesting birds.
- Use an appropriate stocking rate and proper percentage of vegetation utilization to ensure sufficient carry-over and maintained plant vigour and range condition (Hull 2002, Dechant *et al.* 2003a,b,c,d). Apply light to moderate stocking rates, and a proper use factor of 40% and 50% for fescue, and mixedgrass and dry mixedgrass prairie, respectively (Adams *et al.* 1994). Adjust stocking rates in accordance with range site (*i.e.,* soil type, topography, local climate or moisture regime), precipitation zone and range condition (*i.e.,* dominant plant community) (Wroe *et al.* 1988).
- Make seasonal adjustments in stocking rates based on fluctuations in precipitation, time of use and range condition.
- Strategically place salt and water sources to encourage cattle distribution across the landscape (Adams *et al.* 1986).
- Develop a salt placement plan for each pasture to selectively manage for areas of higher use.
- Defer the use of native prairie early in the spring using either deferred-rotation or complementary grazing systems. Deferred early-season use of native prairie can benefit

range health and minimize disturbance to nesting birds (Prescott and Wagner 1996). Complementary grazing systems are best suited to operations where seeded pastures exist or can be created without loss of native prairie (Prescott and Wagner 1996).

- Promote the use of rotational grazing systems that allow pastures to be rested for either an entire season, or part of the season (Messmer 1990, Sedivec 1991, Bowen and Kruse 1993, Mahon 1995, Prescott and Wagner 1996, Stanley *et al.* 1999). Rotational grazing systems can be used to create variable vegetation structure at the pasture level, and provide a means to delay disturbance in at least one field during the peak nesting season.
- Where possible, winter graze fescue grasslands at recommended stocking rates according to range site and range condition (Wroe *et al.* 1988, Mahon 1995, Hull 2002). Mahon (1995) recommended November and December grazing of fescue grasslands in the Milk River Ridge area as a suitable strategy for maintaining habitat for Baird's sparrows. Winter grazing avoids use during the nesting period, helps to reduce dense accumulations of litter and residual vegetation, and may also be more effective for reducing woody cover (Medin 1986, Mahon 1995). Winter grazing is also a recommended strategy to maintain the condition and productivity of rough fescue grasslands that are better adapted to later season use (Adams *et al.* 1994).

9 RESEARCH RECOMMENDATIONS

On-going monitoring of grassland bird populations in the Milk River Basin is necessary to continue to assess population trends and bird response to land use practices. The Grassland Bird Monitoring Pilot Project that was initiated in 2002 may provide a means to more effectively monitor and track trends of grassland birds in the Canadian prairies (Dale *et al.* 2002). This project incorporated information on habitat in conjunction with bird surveys. Long-term monitoring of this kind should be coupled with ongoing applied research to better understand various aspects of grassland bird ecology and response to land use activities.

Key research needs for long-billed curlew, upland sandpiper, Sprague's pipit and Baird's sparrow populations in the Milk River Basin are listed below:

- continue to assess response to habitat fragmentation and determine minimum area requirements (Hill 1998);
- assess the effects of pesticide or herbicide use on survival, nesting success, or prey availability;
- conduct additional basic research to better understand the nesting ecology and nesting habitat characteristics of long-billed curlews, upland sandpipers, Sprague's pipits and Baird's sparrows (Sutter 1997, Green *et al.* 2002);
- collect more information on seasonal survival rates of chicks, subadults and adults to quantify sources of mortality (Dugger and Dugger 2002);
- compare relative use and nesting or fledgling success in dry mixedgrass, mixedgrass and fescue prairie managed under different grazing systems or intensities of use;
- determine long-term trends of grassland birds in response to changes in range condition;

- assess and compare the effects of different intensities and frequencies of burning, grazing and mowing on nest site selection and productivity (De Smet and Conrad 1991);
- compare use and productivity in non-native versus native habitats in the Milk River Basin; and
- compare rates of nest predation or cowbird parasitism in native versus non-native habitats and in varying patch sizes in the Milk River Basin.

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II: MAMMALS

A. OLIVE-BACKED POCKET MOUSE

1 INTRODUCTION

1.1 Background

The purpose of this report is to summarize the ecology and habitat requirements of the olive-backed pocket mouse (*Perognathus fasciatus*) in southern Alberta. Based on this information and supporting scientific studies, the potential effects of livestock grazing on this species and its habitat is discussed. Due to the limited information specific to grazing and olive-backed pocket mice in Alberta, a comparative table of various grazing systems will not be given. The grazing response / management discussion is followed by a summary of recommended beneficial management practices to enhance olive-backed pocket mouse habitat in the Milk River Basin in Alberta, with broader application to the range of this species within the Grassland Natural Region of Alberta (Alberta Environmental Protection 1994). Lastly, a brief summary of research recommendations is provided.

Although widely distributed in the arid grasslands of the Great Plains of the United States, the olive-backed pocket mouse is limited in its distribution to the southeast corner of Alberta (Engley and Norton 2001). Olive-backed pocket mice also occur in south-central Saskatchewan and southwestern Manitoba (Manning and Jones 1988). This small, nocturnal mouse is predominantly found in mixedgrass and dry mixedgrass prairie and is limited to sites with loose, sandy soil in the Milk River Basin (Gummer and Kissner 2004). It has been designated as "Sensitive" in Alberta as there are relatively few documented occurrences of this species in the province (Alberta Sustainable Resource Development (SRD) 2001a). There have only been 4 observations of this species in the vicinity of the Milk River (Gummer and Kissner 2004). Due to their similar habitat requirements, the olive-backed pocket mouse often occurs in association with the Ord's kangaroo rat (*Dipodomys ordii*) in southeastern Alberta. However, there are no records of the Ord's kangaroo rat within the Milk River Basin (Gummer 1997, Gummer and Robertson 2003). The Ord's kangaroo rat is considered "May Be At Risk" in Alberta due to its rarity and dependence on rare and unique sandhill and sand plain habitats (SRD 2001a). Suitable habitat for the Ord's kanagaroo rat and the olive-backed pocket mouse may be declining in Alberta due to vegetation encroachment from altered grazing and fire regimes as well as other human land use changes on the prairies (Gummer 1997). Further research is needed to determine the population status of the olive-backed pocket mouse in Alberta and to determine its response to land use practices such as grazing.

1.2 Ecology

Pocket mice (*Perognathus* spp.), together with kangaroo rats (*Dipodomys* spp.) and kangaroo mice (*Microdipodops* spp.), belong to the heteromyid group of rodents. The kangaroo rat and the olive-backed pocket mouse are the only two heteromyid species found in Alberta (Gummer and Kissner 2004). Heteromyid rodents include some of the most specialized granivorous rodents in North American deserts (Fagerstone and Ramey 1996). These rodents feed predominately on seeds. They have distinctive external cheek pouches that are used to collect and transport large quantities of seeds (Manning and Jones 1988). Heteromyid rodents are thought to be important in seed dispersal and seedling establishment of certain native plants due to their seed caching behaviour (Fagerstone and Ramey 1996). Heteromyids harvest seeds well beyond their immediate food requirements and store the excess in caches located in burrows or in shallow pits dug into the soil surface (Price 1999). Stored seed caches provide nourishment for these rodents over the winter period, while excess seed in these caches serve as an important source of plant recruitment. Although seeds cached in burrows may be buried too deeply to germinate successfully, those buried near the surface are in a more favorable microsite for germination than seeds on top of the ground. Rodents also transport mycorrhizae associated with range plants which may be important for establishing plant species on denuded range sites (Fagerstone and Ramey 1996). Pocket mice tend to influence the establishment of annual plants and small-seeded perennial grasses while kangaroo rats influence establishment of large seeded plants (Fagerstone and Ramey 1996). Selective foraging by these rodents may also be important for stimulating plant species diversity due to feeding on competitively superior plants and their seeds.

All heteromyids are nocturnal and highly fossorial, spending much of their time in underground burrows and emerging to forage at night. Underground burrows are used for sleeping, shelter and birthing. Their nocturnal, fossorial lifestyle is well suited to arid environments and predator avoidance. Olive-backed pocket mice, like Ord's kangaroo rats, tend to forage only during dark nights (with dim moonlight) to avoid being detected by predators (Gummer pers. comm.). Artificial lighting can therefore have negative implications for these species.

Olive-backed pocket mice are generally solitary animals (Smith 1993). These mice go into torpor in their burrows during the winter from mid-October to April, lowering their body temperature to conserve energy (Wrigley *et al.* 1991). Unlike true hibernators, they periodically arouse to feed on stored seeds and can be aroused in a few minutes when disturbed. Gestation periods of approximately 1 month have been reported for olive-backed pocket mice with breeding periods occurring from late April to August (Manning and Jones 1988, Wrigley *et al.* 1991). In southern Manitoba, breeding begins in late April, with the first litter born in late May; a second breeding peak occurs from early July to mid-August (Wrigley *et al.* 1991). Litters may be produced once or twice a year with litter sizes ranging from 2 to 12 young (Manning and Jones 1988, Wrigley *et al.* 1991). Usually 4 to 6 young are born (Pattie and Fisher 1999). Young olive-backed pocket mice become sexually mature in the spring following their birth.

1.2.1 Diet

Olive-backed pocket mice are primarily granivorous and feed mainly on forb and grass seeds. Heteromyid rodents are known to harvest the seeds of a wide variety of plant species (Fagerstone and Ramey 1996). In southern Manitoba, olive-backed pocket mice fed on seeds from weedy forbs such as peppergrass (*Lepidium densiflorum*), black bindweed (*Polygonum convolvulus*) and Russian thistle (*Salsola kali*) (Wrigley *et al.* 1991). Olive-backed pocket mice in this case were found mainly at the edge of, or inside, crop or hayfields where weedy forbs were common (Wrigley *et al.* 1991). Other food items reported from cheek pouches of olive-backed pocket mice in Canada include: knotweed (*Polygonum* spp.), June grass (*Koeleria gracilis*), foxtail barley (*Hordeum jubatum*) and blue-eyed grass (*Sisyrinchium* spp.). These species are predominantly early successional species that colonize disturbed sites. Olive-backed pocket mice are also known to collect and eat small amounts of green vegetation and invertebrates (*e.g.,* grasshopper eggs) (Pattie and Fisher 1999). Like other heteromyids, pocket mice are adapted for water conservation and require little free water to drink, obtaining required water from their food (Fagerstone and Ramey 1996, Gummer 1997).

1.2.2 Predators

Common heteromyid rodent predators include owls, snakes, foxes, weasels (*Mustela* spp.) and American badgers (*Taxidea taxus*) (Gummer 1997).

1.3 Habitat Requirements

1.3.1 General

Olive-backed pocket mice are typically found in open, arid grasslands with loose, sandy soils, and sparse or very short vegetation (Manning and Jones 1988, Reynolds *et al.* 1999, Gummer and Robertson 2003). Sites with low densities of shrubs may be selected to provide cover from raptors and other predators (Gummer and Kissner 2004). Wetlands and riparian habitats or other areas with taller cover or moderate to high shrub densities are usually avoided. Tall vegetation has been found to impede pocket mouse movement (Reichman and Price 1993). Riparian habitats also typically have less workable, fine-textured soils. As olive-backed pocket mice use a hopping style of locomotion they are able to move most easily in bare, open ground with sparse vegetation.

The habitat suitability index (HSI) model for olive-backed pocket mice in the Milk River Basin included five variables: soil texture; percentage of barren ground, graminoids, and shrubs; and habitat type. As olive-backed pocket mice are restricted to grassland habitats, habitat type is the main determining factor in this model (Gummer and Kissner 2004). According to the HSI model, grassland habitats best suited to olive-backed pocket mice have moderate, moderately coarse or coarse textured soils, between 10% to 30% bare ground, between 60% to 80% graminoids and between 5% to 10% shrub cover.

1.3.2 Burrowing Habitat

Olive-backed pocket mice dwell in underground burrows that lead 30 cm to 2 m below the soil surface and can occupy an area of up to 6 meters in diameter (Manning and Jones 1988). As these mice are not strong diggers they prefer loose, sandy soils that facilitate easy burrowing. Soils with moderate, moderately coarse or coarse textures are considered appropriate (Gummer and Kissner 2004).

Salt (2000) reported an association between various mice and vole species including olive-backed pocket mice with Northern pocket gopher burrows in mixedgrass prairie in the Milk River Natural Area. The majority of mice or vole dens in this area were associated with old pocket gopher feeding tunnels. The larger mouse / gopher communities were inhabited by as many as four species, including deer mice (*Peromyscus maniculatus*), olive-backed pocket mice, sagebrush voles (*Lagurus curtatus*) and meadow voles (*Microtus pennsylvanicus*). Similar findings were reported by Wershler (2000) at the Antelope Creek Habitat Development Area, near Lake San Francisco, Alberta. In this case, however, voles and mice were reliant on old Richardson's ground squirrel tunnels as pocket gophers were largely absent in the area.

1.3.3 Foraging Habitat

Pocket mice typically forage under perennial vegetation to provide cover from predators and secure seed resources (Price and Brown 1983). Olive-backed pocket mice are most abundant in areas with an intermediate amount of bare ground (approximately 20%) (Gummer and Kissner 2004).

1.3.4 Area Requirements

Olive-backed pocket mice are thought to have very small home ranges. Much of their time is spent in underground burrow complexes which are typically less than 10 m in diameter (Manning and Jones 1988). The largest documented movements of this species are less than 100 m (Prefaur and Hoffman 1975).

1.4 Olive-Backed Pocket Mouse Response to Grazing

Vegetation structure is thought to play a major role in determining the general composition of grassland small mammal communities (Grant *et al.* 1982). Studies have found discernible differences between species diversity, total small mammal biomass and community composition along a reduced vegetation cover gradient from tallgrass to mid to shortgrass prairie (Grant *et al.* 1982). Precipitation, grazing and fire are the predominant factors that determine the structure and function of grasslands (Jones *et al.* 2003). In general, small mammals found in taller grass communities are more markedly influenced by reduced vegetation cover than small mammals such as the olive-backed pocket mice or the Ord's kangaroo rat that are adapted to short or sparse vegetation (Grant *et al.* 1982).

In addition to influencing vegetation cover, domestic or wild ungulate grazing affects plant species composition and diversity, primary productivity, standing crop biomass, soil compaction and soil moisture attributes (Grant *et al.* 1982). These attributes can impact the availability of food and the stability of small mammal burrows. Grazing has the potential to negatively impact heteromyid rodents due to direct trampling of burrows and soil compaction or by removing seed heads (Heske and Campbell 1991, Gummer pers. comm.). Grazing may benefit olive-backed pocket mice and other seed-eaters if it results in an increase in the abundance of annual grasses, forbs or shrubs that produce more seeds than perennial grasses (Grant *et al.* 1982, Jones and Longland 1999). Studies have found that livestock grazing was important for increasing forb species richness in mixedgrass prairie in southwestern Saskatchewan (Thorpe and Godwin 2003).

Jones *et al.* (2003) compared small mammal communities between grazed and ungrazed grassland in southeastern Arizona. Ungrazed sites were excluded from cattle for 33 years. According to the results of this study, heteromyid rodents as a group were more common on grazed plots and were positively correlated with bare ground cover. In contrast, murids (members of the Mouse family) were significantly more common on ungrazed plots with taller vegetation cover. Of the heteromyids studied, Kangaroo rats (*Dipodomys* spp.) were most tolerant of grazing in arid landscapes, while pocket mice showed an intermediate response to grazing.

Few studies have specifically assessed the response of olive-backed pocket mice to grazing in Alberta or elsewhere in its range. The pocket mice of the Great Plains, as a group, show varying responses to grazing (Fagerstone and Ramey 1996). Several species such as the Great Basin (*Perognathus parvus*), Price (*P. penicillatus*) and Bailey (*P. baileyi*) pocket mice prefer heavier protective cover of either perennial grasses or shrubs and are reduced by heavy grazing. In contrast, the Arizona pocket mouse (*P. amplus*), silky pocket mice (*P. flavus*) and the hispid pocket mice (*P. hispidus)* are found in more open areas with sparse grass cover and respond favourably to grazing (Fagerstone and Ramey 1996). As olive-backed pocket mice prefer open habitats with sparse and short vegetation and moderate amounts of bare ground, it is likely that grazing will similarly benefit this species (Gummer pers. comm.). Grazing may be particularly beneficial if it contributes to maintaining active sand dune complexes that are important to olive-backed pocket mice and Ord's kangaroo rats in Alberta. Trampling and grazing along sandy formations can lead to localized blowouts and reactivation of sand dune complexes (Houston 2000). Blowouts and erosion form along well-used paths and areas with heavily reduced vegetation cover. Localized erosion also results from heavy livestock use points such as at water sources or salting stations. In recent years, Ord's kangaroo rats have been found to be increasingly abundant on roads, fireguards and other human-disturbed areas in the sandhills in the northern portion of the Canadian Forces Base (CFB) Suffield National Wildlife Area (Gummer 1997, Gummer pers. comm.). This area has been excluded from grazing since the 1970's, a factor which is thought to have contributed to the apparent stabilization of sand dunes in the area and which may explain the shift in habitat use by kangaroo rats from natural habitats to human-disturbed areas (Gummer pers. comm.). The effects of this shift in habitat use on kangaroo rat predation rates, parasitism, diet and winter microclimates is currently being investigated (Gummer pers. comm.). A similar habitat shift may be occurring with olive-backed pocket mice, although further research is required. Due to their smaller home ranges, olive-backed pocket mice require smaller patch sizes of suitable habitat than Ord's kangaroo rats.

1.5 Grazing Systems and Olive-Backed Pocket Mouse Habitat Management

In general, conservative stocking rates are suggested for sandy range sites due to the greater potential for erosion (Houston pers. comm.). Once-over grazing is also recommended whereby pastures are grazed only once during a single season (Houston pers. comm.). These recommendations are geared toward maintaining sustainable forage productivity and adequate carryover of organic residue (litter) but may not allow for adequate disturbance to maintain active dunes and areas of short and sparse vegetation necessary to sustain high densities of olive-backed pocket mice or other rare species. The decision to locally increase stocking rates or apply twice-over grazing should first consider the needs of other priority management species and the potential economic impacts on the ranching operation. Because olive-backed pocket mice have small home ranges and occupy burrow complexes less than 10 m in diameter, only small patches of suitable habitat are required. Thus, conservative stocking rates may be appropriate for maintaining habitat for this species where livestock distribution tactics are used effectively to shift patches of heavy use over the landscape. Shifting areas of high livestock use followed by periodic rest can create localized areas suitable for colonization by olive-backed pocket mice.

Deferred spring grazing may be beneficial to olive-backed pocket mice as it allows for improved seed production, seedling establishment and restored plant vigour (Adams *et al.* 1991). This has benefits in terms of improving food supplies available to pocket mice. Deferral requires ranchers to have alternate forage sources in the spring, such as the use of seeded pastures (*i.e.,* complementary grazing). Deferral can also be achieved using deferred rotation grazing whereby spring use is alternated between multiple pastures from year to year (Adams *et al.* 2004). Season-long (or continuous) grazing may also be favourable for pocket mice if it creates a diversity of patch types with variable vegetation canopy, litter cover and exposed soil due to variable grazing pressure. Light to moderate stocking rates, as well as appropriate use of livestock distribution tools help to promote patch diversity under a season-long grazing system (Adams *et al.* 2004). Season-long grazing under heavy stocking rates tends to promote uniform grazing effects and may be detrimental to promoting seed production.

1.6 Beneficial Management Practice Recommendations

The maintenance and appropriate management of sandhill, sand plain and sand dune habitats is important for olive-backed pocket mice and other rare flora and fauna in the Milk River Basin. Sandhill habitats are fragile ecosystems that are sensitive to disturbance and not suited to cultivation.

The following general land use and grazing recommendations provide a variety of means by which to protect or maintain suitable habitat for the olive-backed pocket mouse within the Milk River basin and throughout the Grassland Natural Region of Alberta. Further research is required (Section 1.7) to improve our understanding of this species in order to evaluate or refine appropriate management recommendations.

1.6.1 General Recommendations

- Protect existing native prairie sandhill or sandy range site habitats from cultivation or extensive development. Although cultivated areas may be used by pocket mice, these areas do not provide secure habitats due to the potential for burrows to be destroyed due to farm machinery, as well as the adverse effects associated with herbicide or pesticide use.
- Avoid use of herbicides or pesticides near known olive-backed pocket mouse habitats due to potential for direct poisoning or consumption of contaminated grains by pocket mice.
- Avoid widespread poisoning programs involving distribution of poisoned grain such as for Richardson's ground squirrel control. Localized areas of disturbance created by Richardson's ground squirrels provide important habitat for olive-backed pocket mice (Salt 2000, Wershler 2000, Gummer pers. comm.). Pocket mice and other granivorous rodents are also vulnerable to consumption of poisoned grain.
- Maintain low to moderate (5% to 10%) shrub densities in pocket mice habitats (Gummer and Kissner 2004). Shrub cover is important for providing cover from predators and higher seed densities.

- Avoid night-time traffic or night-time construction activity in sandhill type areas where olive-backed pocket mice are likely to occur (Gummer pers. comm.).
- Where possible, conduct pre-development surveys to locate potential olive-backed pocket mice burrows. Use the HSI map to map out high priority areas to survey or to avoid during pre-development planning and pipeline routing. The HSI map should be revised or refined based on new information or the availability of additional Geographic Information System (GIS) layers. Spot-lighting or live-trapping can be used to survey for pocket mice (Gummer pers. comm.). Olive-backed pocket mice surveys may help to locate otherwise undetected populations of Ord's Kangaroo rats within the Milk River Basin due to their similar habitat preferences (Gummer pers. comm.).
- Minimize artificial lighting in olive-backed pocket mice habitat from facilities or due to night-time drilling or pipeline construction where bright lighting is required (Gummer pers. comm.). Olive-backed pocket mice, like Ord's kangaroo rats, tend to forage only during dark nights and minimize their aboveground activity during relatively bright night-time conditions (*e.g.,* moonlight) (Gummer 1997, Gummer pers. comm.). This behaviour is thought to be a predator avoidance strategy. Therefore, these rodents have a limited number of suitable foraging nights available during periods of seed availability in which to gather the resources required to survive the 6 to 8 month hibernation period.
- Pipeline construction during hibernation (*i.e*., from October to April) is preferred, when burrows are not directly impacted (Gummer pers. comm.).
- Avoid leaving open trenches (*e.g.*, from pipelines) in pocket mouse habitats during the spring and summer months (Gummer pers. comm.). Trenches create a trap for both mice and snakes incurring greater risks of predation to olive-backed pocket mice.
- Avoid heavy, uncontrolled off-road vehicle traffic through areas with potential olive-backed pocket mice burrows to avoid burrow destruction.

1.6.2 Grazing Recommendations:

Properly managed livestock grazing is often considered the most sustainable use of sandhill or sand plain habitats (Houston 2000). Some degree of grazing may indeed be required to maintain active sand dune complexes (Houston 2000). Grazing is also important for stimulating plant species diversity and creating patches of short vegetation and reduced litter that are suitable for olive-backed pocket mice. A mosaic of grazing pressure is likely preferable to ensure a stable seed source, while creating locally heavily grazed areas with sparse vegetation and patches of bare soil. Appropriate grazing systems for olive-backed pocket mice should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

To promote habitat for olive-backed pocket mice, the following general grazing principles apply:

- Promote deferred spring grazing through the use of either complementary or deferred rotation grazing to allow seed set and improved plant vigour.

- Promote patchy grazing with a gradation of light to heavily grazed patches across the landscape. This may be achieved through moderate stocking rates and appropriate livestock distribution tactics.
- Apply distribution tactics such as herding and salt or water placement to create a shifting pattern of localized heavy use across the landscape. Allow for periodic rest of heavily used patches. Heavy use patches with 10% to 30% bare ground, 60% to 80% graminoids and 5% to 10% shrub cover will provide suitable habitat for olive-backed pocket mice (Gummer and Kissner 2004).

1.7 Research Recommendations

The scarcity of olive-backed pocket mouse records within the Milk River Basin underscores the need for further population surveys to be conducted in this region. These surveys could be designed to provide more information about plant community types that olive-backed pocket mice are associated with, their relationship with range health, and their association with either natural or human-disturbed habitats. These surveys may also provide information about the level of grazing intensity and type of grazing system best suited for creating habitat for pocket mice while maintaining rangeland productivity. There is a general need to learn more about the use of controlled grazing or prescribed burning as mechanisms to maintain the structure and function of active sand dune complexes for rare flora and fauna (Houston 2000). More in-depth studies of olive-backed pocket mice could also be done to assess their survival and reproduction, hibernation patterns, and home range and seasonal movement (Gummer pers. comm.). Other studies could further examine olive-backed pocket mouse associations with larger burrowing mammals such as northern pocket gophers or Richardson's ground squirrels (Salt 2000, Wershler 2000). Ongoing studies of Ord's kangaroo rats in CFB Suffield continue to provide the opportunity to collect incidental information about olive-backed pocket mice. An assessment of the potential effects of kangaroo rat occupation of human-disturbed areas at Suffield may have particular relevance to pocket mouse habitat management in the Milk River Basin.

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B. SWIFT FOX, AMERICAN BADGER AND RICHARDSON'S GROUND SQUIRREL

1 INTRODUCTION

The purpose of this report is to summarize and compare the ecology and habitat requirements of the swift fox (*Vulpes velox*), American badger (*Taxidea taxus taxus*) and Richardson's ground squirrel (*Spermophilus richardsonii*) in southern Alberta. Based on this information, livestock grazing interactions and the potential implications of various grazing systems on these species and their habitat are discussed. This discussion is followed by a summary of recommended beneficial management practices to enhance habitat for these species in the Milk River Basin in Alberta and throughout their range in the Grassland Natural Region of Alberta. Lastly, a brief summary of additional information needs is presented.

The swift fox, American badger and Richardson's ground squirrel have similar habitat preferences and are ecologically linked due to their mutual reliance on underground burrows for breeding, shelter and predator avoidance. Richardson's ground squirrels are also an important prey item for badgers and to a lesser extent for swift fox. Historically, these three mammals coexisted with bison (*Bison bison*) throughout their range across the plains of North America. Presently, livestock grazing is the dominant land use in the native prairie habitats occupied by these species in southern Alberta. In addition to grazing management, it is also important to consider strategies to minimize potential impacts due to other human activities and land use practices which can pose a risk to these species or their habitats.

2 SWIFT FOX

2.1 Background

The swift fox, North America's smallest canid, was once common throughout the short and mixedgrass prairie regions (Cotterill 1997, Moehrenschlager and Moehrenschlager 2001, Schauster *et al.* 2002). The swift fox experienced dramatic range-wide declines in the late 1800s and early 1900s leading to their extirpation from Canada and northern Montana by the late 1930s (Cotterill 1997, Moehrenschlager and Moehrenschlager 2001). The arrival of European settlers and the concurrent extensive loss of native prairie habitat and alteration of prairie ecosystems as well as unregulated trapping, shooting, and incidental poisoning, are thought to be the primary factors responsible for this population crash (Carbyn 1995, Brechtel *et al.* 1996, Cotterill 1997, Moehrenschlager and Moehrenschlager 2001). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) officially designated the swift fox as "Extirpated" in Canada in 1978 (Cotterill 1997). However, as a result of reintroduction efforts over a 14-year period, small populations of swift fox have been reestablished in southern Alberta and Saskatchewan (Moehrenschlager and Moehrenschlager 2001). The swift fox is currently legislated as "Endangered" under Alberta's *Wildlife Act* and the federal *Species at Risk Act (SARA)*. The most recent COSEWIC status assessment was conducted in May 2000 (COSEWIC 2002). The general status of the swift fox in Alberta is "At Risk" (Alberta Sustainable Resource Development (SRD) 2001a).

The swift fox is associated with the Great Plains and at one time was found as far north as Red Deer, Alberta, and as far south as northern Texas (Pattie and Fisher 1999). Their historical range coincided with that of the North American bison (Smeeton and Weagle 2000). Due to reintroduction efforts, swift fox are presently found in 40% of their historical North American range (Moehrenschlager and Moehrenschlager 2001). Their current range is limited to two small pockets in Canada, one along the Alberta / Saskatchewan / Montana border and a second smaller pocket located in the Grasslands National Park of Saskatchewan (Cotterill 1997). In the United States, there are currently low abundances of swift fox in Montana, Nebraska, and South Dakota; higher abundances occur in Colorado, Kansas, and Wyoming, and in parts of Texas, New Mexico and Oklahoma (Cotterill 1997, Schauster *et al.* 2002).

The Swift Fox Reintroduction Program began in Canada in 1983 and continued until 1997 (Moehrenschlager and Moehrenschlager 2001). Swift fox recovery efforts in Canada were spearheaded by Miles and Beryl Smeeton, owners of the now-named "Cochrane Ecological Institute", located near Cochrane, Alberta. A total of 841 captive-raised swift foxes and 91 translocated swift foxes were released into southeastern Alberta and southwestern Saskatchewan (Smeeton and Weagle 2000). Areas chosen for swift fox reintroduction were mainly composed of grazing lands and mixedgrass prairie (Herrero *et al.* 1986). Following reintroduction efforts, a winter census conducted from 1996 to 1997 estimated the Canadian population of swift foxes to be approximately 289 foxes (Cotterill 1997). A more recent census of populations in Alberta, Saskatchewan and Montana conducted from 2000 to 2001, revealed that the swift fox population has increased over a 4-year span without the supplementation of swift fox releases (Moehrenschlager and Moehrenschlager 2001). The Canadian population of foxes was estimated to have increased from 289 foxes to 656 foxes (Moehrenschlager and Moehrenschlager 2001). Although the results of the survey are encouraging, it has been debated as to how many individuals are needed to maintain a self-sustaining, viable population with sufficient genetic variability (Moehrenschlager and Moehrenschlager 2001). Several factors limit the long-term re-establishment of the swift fox in Alberta and Saskatchewan including: vulnerability to poisoning (rodenticides or pesticides); predator control programs; predation; interspecific competition with coyotes (*Canis latrans*) and red foxes (*Vulpes vulpes*); a changing prey base; canid disease; continuing habitat fragmentation and habitat loss; increasing agricultural, urban, and industrial development; and road mortalities (Carbyn 1995, Cotterill 1997, Sovada *et al.* 1998). Due to its small size, the Canadian swift fox population is also vulnerable to climatic conditions such as drought or severe winters (Cotterill 1997).

Sixty-one swift foxes were released in the Milk River area in 1989 (Moehrenschlager and Moehrenschlager 2001). Reintroduction into the Milk River Ridge region was discontinued due to a rabies outbreak in the skunk population.

2.2 Ecology

The breeding season for swift fox usually begins in late January, with pups produced from late April to early May (Cotterill 1997, Pattie and Fisher 1999). The preliminaries of courting can take a long time for newly paired foxes as they are "fastidious" in mate selection (Weagle and Smeeton 1995). Swift fox appear to be monogamous and will establish a pair bond if they are successful breeders (Scott-Brown *et al.* 1986). Litter sizes range from between 3 to 6 young (Olson and Lindzey 2002a). Prey abundance is thought to influence swift fox productivity (Olson and Lindzey 2002a). Breeding may begin within the first year of age, with the first breeding season occurring later than usual (Cotterill 1997). During breeding, activity centers around the natal den (Alberta Fish and Wildlife Division (FWD) 1990). Newborn pups depend on their parents for food and protection (FWD 1990). Initially, females remain underground with the pups while male foxes hunt and bring food to the den. Pups are weaned at 6 to 7 weeks but will stay near the den and with the adults for several months (FWD 1990). Juvenile foxes will typically disperse in the late summer and autumn when they reach 4 to 5 months of age (Cotterill 1997). It is at this time of year that swift fox relocation efforts have proven most successful (Smeeton and Weagle 2000).

Swift fox are generally more active at night, however, their activity patterns can vary seasonally (Smeeton and Weagle 2000). Swift fox in captivity can survive up to 14 years, however, the lifespan of foxes in the wild is typically between 3 to 6 years (FWD 1990).

2.2.1 Diet

Swift foxes are nocturnal, opportunistic feeders whose food habits vary seasonally and consist of a variety of prey including mammals, carrion, invertebrates, vegetation (seeds, berries, and grass), amphibians, reptiles, and small birds (Cutter 1958a, Carbyn 1995, Brechtel *et al.* 1996, Cotterill 1997, Sovada *et al.* 2001). In Northern ranges the most important source of food, particularly during the winter, is thought to be small mammals, mainly microtines (voles) (Carbyn 1995, Pattie and Fisher 1999, Moehrenschlager pers. comm.). Similarly, swift fox density in southeastern Colorado has been positively correlated with rodent abundance (Schauster *et al.* 2002).

An analysis of swift fox food habits in Alberta and Saskatchewan found that the mammalian component of their diet consisted primarily of small rodents (64.1%) and ungulate carrion (23.6%) (Reynolds *et al.* 1991). Lesser amounts of lagomorphs (5.2%) were also consumed (Reynolds *et al.* 1991). Moehrenschlager (2000) found that Richardson's ground squirrels comprised between 25% to 30% of swift fox diets south of the Cypress Hills, Saskatchewan. Richardson's ground squirrels are only consumed outside of the winter hibernation period, when they are active aboveground. Mammalian remains that were most common in swift fox scat from Nebraska were: 25% jackrabbit (*Lepus* spp.), 48% prairie vole (*Microtus ochrogaster*), 38% cattle, and 31% western harvest mouse (*Reithrodontomys megalotis*). Overall, mammals and insects were the most frequently occurring items in swift fox scat from Nebraska, however, 54% of scats also contained plant material and 40% contained bird remains (Hines and Case 1991). Insects (grasshoppers in particular) are considered to be an important food source for foxes in Alberta and Saskatchewan particularly in autumn (Moehrenschlager pers. comm.). Winter is considered to be the most critical food limiting period for foxes in Canada as that is when only microtines (voles), rabbits, carrion and some birds are available (Scott-Brown *et al.* 1986). Snow depth may also limit availability of food during the winter (Carbyn 1995).

2.2.2 Predators

Several studies have found that predation by coyotes is the main cause of swift fox mortality throughout its range (Carbyn 1995, Sovada *et al.* 1998, Kitchen *et al.* 1999, Olson and Lindzey 2002a, Kamler *et al.* 2003). Kamler *et al.* (2003) recently reported that coyotes were responsible for at least 89% of swift fox mortalities in the Rita Blanca National Grasslands in northwestern Texas. The coyote is both a competitor and a predator of the swift fox (Brechtel *et al.* 1996, Kamler *et al.* 2003). Swift foxes killed by coyotes may be eaten, or killed and left (Brechtel *et al.* 1996). Coyote populations are much higher than in the past due to the elimination of wolves from the prairies and the ability of coyotes to adapt to modified prairie landscapes (Brechtel *et al.* 1996). Predation by large raptors such as golden eagles is also considered to have a significant impact on swift fox populations (Smeeton pers. comm.). Predation by badgers and bobcats has also been recorded (Brechtel *et al.* 1996, Olson and Lindzey 2002a).

2.3 Habitat Requirements

2.3.1 General

Swift foxes generally prefer short, dry mixedgrass or mixedgrass prairie with flat to gently rolling terrain and sparse vegetation that allows for visibility and good mobility (Cotterill 1997). Native species such as blue gramma (*Bouteloua gracilis*), spear grass (*Stipa comata*), fescue (*Festuca* spp.) and pasture sage (*Artemesia frigida*) are common plants in these areas (Cotterill 1997). Swift fox typically avoid cultivated lands, coulees and brushy areas (Cotterill 1997). Some studies have found that swift foxes in the United States occupy areas with mixed agricultural use, however, plowed fields do not typically offer suitable den sites (Sovada *et al.* 1998, Jackson and Choate 2000).

Brechtel *et al.* (1996) identified three essential habitat features for swift fox:
i) extensive tracts of native grassland; ii) presence of burrowing mammals and soil type suitable for denning; and iii) microtine rodent populations.

2.3.2 Denning Habitat

Dens are a critical habitat component for swift fox. Swift fox use multiple den sites for shelter, rearing young, and to escape from predators (Cotterill 1997). Availability of suitable dens, such as badger burrows, significantly improves the odds of predator avoidance and is thought to be a critical factor affecting the maintenance of viable swift fox populations (Pruss 1999, Moehrenschlager pers. comm.). Badger burrows do not need to be further excavated and provide readily accessible predator escape dens. Swift foxes will also excavate their own dens or modify ground squirrel burrows. Swift foxes are known to use dens throughout the year, and may even use the same one for a lifetime (Scott-Brown *et al.* 1986, Pattie and Fisher 1999).

Den location and physical characteristics are important criteria in determining the suitability of natal or rearing den sites (Pruss 1999). Natal or rearing dens typically have more entrances than temporary escape or shelter dens (Pruss 1999). Den location varies depending on local topography, however, well-drained sites with good visibility in all directions are typically preferred (Cutter 1958b, Scott-Brown *et al.* 1986, Cotterill 1997, Jackson and Choate 2000). Consequently, the tops of hills with a gradual slope provide favorable natal den sites (Pruss

1999). Locating dens on hilltops allows for improved predator detection and minimizes the probability that dens will be flooded during snowmelt or heavy rainfall (Pruss 1999). Dens have also been located in level terrain on shortgrass prairie (Cotterill 1997, Pruss 1999). Soil type and aspect may also be important criteria in den site selection (Hines and Case 1991). Hines and Case (1991) reported that 79% of 19 dens in Nebraska were located in sandy loam soils with the remainder in loamy sand. Dens with east and west exposures were also preferentially selected (Hines and Case 1991). No preference was found for a particular den entrance angle for dens in southeastern Alberta and southwestern Saskatchewan (Pruss 1999).

In Texas, it was observed that swift foxes constructed dens in "overgrazed", barren areas with little or no bushes or tall plants (Cutter 1958b). However, in southeastern Alberta and southwestern Saskatchewan, Pruss (1999) found that occupied natal dens were located in areas where old grass was significantly higher than at unoccupied sites. Pruss (1999) suggests that the preference for relatively taller grass may be related to the availability of insect prey. Similarly, Uresk *et al.* (2003) found that vegetation at swift fox dens in South Dakota had a greater vegetation height density than random locations (approximately 12 cm versus 10 cm visual obstruction readings (VOR)). Total vegetation height significantly improves hiding and screening cover for foxes at dens (Uresk *et al.* 2003).

Both Pruss (1999) and Hines and Case (1991) found an association between proximity of dens to roads. Hines and Case (1991) reported that 68% of swift fox dens were within 230 m of roads; similarly, Pruss (1999) found that 81% of occupied dens were within 200 m of roads. Pruss (1999) speculates that proximity to roads may be due to avoidance of coyotes, availability of vehicle-killed carrion as a food source, and the use of roads as travel corridors. However, the proximity of dens to roads may also increase potential vehicle collision mortalities. Black *et al.* (1998) found that vehicle trauma was a significant cause of death among young of the year foxes in Alberta and Saskatchewan.

2.3.3 Foraging Habitat

Selection of suitable foraging sites is influenced by various factors including avoidance of predators or competitors such as coyotes or red fox, availability of escape dens and cover, and availability of suitable prey (Moehrenschlager pers. comm.). In general, swift fox forage in open mixedgrass prairie with short vegetation that allows for ease of movement and foraging efficiency (Smeeton pers. comm.). Swift fox are more vulnerable to predators in taller vegetation (Moehrenschlager pers. comm.). Cattle grazing is considered important for maintaining patches of suitably short vegetation (Smeeton pers. comm.). Although there is usually an abundance of various prey available to foxes during the summer, availability of mammalian prey during the winter is considered limiting (Carbyn 1995). Vegetation patchiness and structural diversity is considered important for maximizing the availability and stability of a diverse mammal prey base (Fagerstone and Ramey 1996).

Uresk *et al.* (2003) found that the vegetation characteristics of swift fox foraging habitat in South Dakota were similar to denning habitats, with more dense vegetation than random sites. Olson and Lindzey (2002a) attribute the higher productivity of swift fox in their southeastern Wyoming study area to a positive association between the proportion of sage vegetation within the parent's home range and prey abundance in sagebrush habitats. Olson and Lindzey (2002a) noted that sagebrush-grassland habitats had higher relative abundance of prey (including small mammals, breeding birds, and insects) than grassland habitats in southeastern Wyoming. Important prey items such as 13-lined ground squirrels (*Spermophilus tridecemlineatus*), deer mice (*Peromyscus maniculatus*), and various beetles have all been positively associated with shrub microhabitats (Olson and Lindzey 2002a). Additional research is needed to define the characteristics and seasonal variation of swift fox foraging habitat and microhabitat selection in Alberta and Saskatchewan.

2.3.4 Area Requirements

Fox home ranges vary across time, sex, season, and year, and also appear to be related to prey availability and distribution (Hines and Case 1991, Olson and Lindzey 2002b, Schauster *et al.* 2002). Olson and Lindzey (2002b) suggest that home range size may be an indicator of habitat productivity, with decreasing home range size in more productive habitats. Home range variations may also be due to natural physical boundaries, such as roads or rivers that constrict home range boundaries (Hines and Case 1991). Based on home range data from 16 swift foxes in the Alberta / Saskatchewan border area, an average home range size of approximately 34.1 km^2 was reported (Cotterill 1997). This is similar to an average home range estimate of 32.3 km^2 reported for 7 adult foxes in Nebraska (Hines and Case 1991). However, home ranges reported for wild foxes on native shortgrass prairie in southeastern Colorado and in southeastern Wyoming were significantly smaller (Olson and Lindzey 2002b, Schauster *et al*. 2002). Given their nocturnal nature, Schauster *et al.* (2002) found that swift fox home ranges in southeastern Colorado were largest (9.4 ± 4.9 km^2) and spatial overlap was greatest at night. During the day fox social units, ranging from 2 to 4 foxes, used dens and had reduced home ranges of 2.8 ± 2.2 km^2. Denning areas were not commonly shared between social units. These findings suggest that while nocturnal foraging areas are commonly shared by various social groups, foxes showed some degree of territoriality toward denning areas (Schauster *et al.* 2002). Olson and Lindzey (2002b) also suggest that swift foxes may be territorial due to limited core-area home range overlap between adjacent pairs of foxes in southeastern Wyoming. Annual home range size of foxes in southeastern Wyoming was approximately 19 km^2. The home ranges of both sexes was smallest during the pup-rearing period, but more so for females than males.

Swift fox home ranges have been noted to expand in the winter in order to accommodate reduced prey availability (Coterill 1997, Olson and Lindzey 2002b). Swift fox densities have similarly been found to increase in better quality habitats and have been positively correlated with rodent prey abundance (Schauster *et al.* 2002). Swift fox density may be inversely related to home range size as home-range dispersion patterns may be influenced by the presence of other fox pairs (Olson and Lindzey 2002b).

Dispersal distances for wild-born juvenile foxes from natal dens require further study (Cotterill 1997). Covell (1992) reported dispersal distances of 9.4 ± 1.7 km for juvenile males and 2.1 ± 0.2 km for juvenile females in southeastern Colorado. Schauster *et al.* (2002) reported that juvenile disperses traveled distances ranging from 8.4 km to 15.9 km in southeastern Colorado.

3 AMERICAN BADGER

3.1 Background

Of the four subspecies of American badger, the subspecies *Taxidea taxus taxus* occurs in the parkland and grassland regions of Alberta from the North Saskatchewan River south to the Montana border and from the foothills east to the Saskatchewan border (Scobie 2002). The badger population in Canada was significantly impacted historically by trapping harvests (Scobie 2002). Currently, even the most generous badger population estimates are only about half of the known 18, 000 badger pelts that were harvested in 1928 (Scobie 2002). Although badgers have expanded their range in some areas due to the clearing of forests, cultivation is thought to have decreased suitable badger habitat on the prairies (Scobie 2002). Badgers are presently considered "Sensitive" and may require special attention in the future to prevent them from becoming at risk of extirpation in Alberta (SRD 2001a). Although more information is needed regarding badger population trends in Alberta, populations are thought to be decreasing provincially (Scobie 2002). Twenty two badger sightings in the Milk River Basin have been recorded in the Biodiversity / Species Observation Database (BSOD), the most recent sighting was in 2003 (Downey pers. comm.).

Habitat loss and alteration, trapping harvest, road kills, shooting, poisoning, and suspected declines of essential prey species (*i.e.*, northern pocket gopher (*Thomomys talipoides*) and Richardson's ground squirrel) are considered to be limiting factors for badger populations in Alberta (Scobie 2002). Badgers are considered ecologically important in the prairie landscape because their burrows provide cover, nesting and denning opportunities for other species including swift fox, snakes, invertebrates, burrowing owls (*Athene cunicularia*), and a host of other organisms (Carbyn *et al.* 1999, Scobie 2002). Badger diggings also help to aerate the soil, promote the formation of humus, and allow water to quickly reach deeper soil levels (Scobie 2002).

3.2 Ecology

American badgers are nocturnal, fossorial (digging, burrowing) mammals. Badgers typically mate in July and August, and have delayed implantation until February resulting in a spring birth (Pattie and Fisher 1999, Scobie 2002). Badgers are polygynous, with males having more than one mate. Between April and June, 1 to 5 young are born in a litter. At 3 to 4 months of age the young disperse and are sometimes seen in unsuitable habitat (Scobie 2002). Most badgers reach sexual maturity by 1 year of age (Pattie and Fisher 1999). A badger can live up to 14 years, however most do not live more than 4 years (Scobie 2002). Badgers enter into torpor (a period of reduced activity) in their burrows during the winter (Scobie 2002).

3.2.1 Diet

American badgers are mainly carnivorous, opportunistic feeders and mainly feed on northern pocket gophers and Richardson's ground squirrels in Alberta (Sovada *et al.* 1999, Scobie 2002). Time of year and badger maturity influence the availability and selection of food (Sovada *et al.* 1999). Michener (2000) found that badgers in southern Alberta cache and retrieve Richardson's ground squirrels. It was suggested that badgers cache food for future energetically stressful periods. The two main high energy demand periods occur during winter and lactation. The caching of ground squirrels was concentrated in autumn, during October and November, with cache retrieval extending into early December (Michener 2000). Obtaining excess food reserves in autumn is important for badgers to prepare for the winter and prolonged periods of reduced activity. Badger predation in autumn coincided with periods when most ground squirrels were in hibernation. A concentrated period of badger predation on un-weaned infant ground squirrels in the spring was also reported, prior to their emergence above ground (Michener 2000).

A seasonal prey and food study conducted in central Alberta, revealed that northern pocket gophers were considered the major food item from late March or early April to early July (Salt 1976). Richardson's ground squirrels made up a dominant component of the badger diet from mid-July to early October. In October, meadow voles (*Microtus pennsylvanicus*) and insects, especially beetles and grasshoppers, accounted for the majority of their diet (Salt 1976). Birds, eggs, reptiles, amphibians, invertebrates, fish, mollusks, and plant material are commonly used to supplement the badger's diet (Scobie 2002). Duck eggs were found to be commonly consumed by badgers in Minnesota and North Dakota during the duck nesting season (Sovada *et al.* 1999). Badgers have also been known to scavenge carrion such as cattle, lagomorphs, and road-kill (Sovada *et al.* 1999). Abundance of prey is considered a strong factor in determining the distribution of badgers (Apps *et al.* 2002). Badgers catch most of their fossorial and semi-fossorial prey by digging them out. Badgers hunt primarily at night and remain underground during the day (Scobie 2002).

3.2.2 Predators

Common badger predators include bears *(Ursus sp.)*, other badgers, wolves (*Canis lupis*), cougars (*Felis concolor*), golden eagles (*Aquila chrysaetos*), and bald eagles (*Haliaeetus leucocephalus*) (Scobie 2002). Predation by coyote packs on badgers has also been reported (Scobie 2002).

3.3 Habitat Requirements

3.3.1 General

Badgers are commonly found in open grasslands with friable soils, little woody cover (shrubs or trees), and within close proximity to a suitable food source, such as Richardson's ground squirrel colonies (Scobie 2002). Badgers in southeastern British Columbia were most often associated with dry, open range and southern aspects (Apps *et al.* 2002). Preferred badger habitat was also positively associated with linear disturbances, fine sandy-loam textured soils, open habitat, and glacio-fluvial deposits (Apps *et al.* 2002). A negative association was found with gravelly areas, forest cover, elevation, ruggedness, and colluvial deposits.

The habitat suitability index (HSI) model for badgers in the Milk River Basin included four variables: soil texture; graminoid coverage; slope; and roadways (Downey 2004a). According to the HSI model, quarter sections which contained steep slopes, less than 70% graminoids, coarse or very fine soils, and that were close to main roadways were rated as poor badger habitat. Moderately coarse (sandy loam), medium (loam, silt loam and silt), and moderately fine (sandy clay loam, silty clay loam, and clay loam) soils are considered preferable for burrow construction and stability. A graminoid coverage of 20% was chosen as the minimum requirement for suitable badger habitat, while habitats with greater than 70% graminoids were given an optimal suitability index rating. Slopes between 0 to 15 degrees were determined to be most representative of suitable badger sites. A buffer of 400 m to the nearest roadway was considered optimal to reduce the risk of vehicle mortalities.

3.3.2 Denning Habitat

A burrow or den is vital to a badger as it is used for giving birth and rearing young, food storage, foraging, and as a diurnal activity site throughout the year (Scobie 2002). Dens may be reused by the same or other badgers and are variable in characteristics (Lindzey 1976). Soil texture is an important factor (see HSI model). Badgers dig their own dens or excavate Richardson's ground squirrel burrows (Pattie and Fisher 1999). A natal den may be up to 10 meters long and have a diameter of 30 cm (Scobie 2002). Natal dens typically only have one entrance and a mound twice the size of day-use dens (Lindzey 1976). A nest consists of bulky grasses in an expanded chamber. Sargeant and Warner (1972), found that radio collared badgers were never located in more than one den on any day. In fact, a female badger was noted to have only reused two of her 46 known dens and was never found in the same den on two consecutive days in a summer season (Sargent and Warner 1972). When observed in the winter, the winter den was the last used den in the summer activity period.

3.3.3 Foraging Habitat

As badgers are opportunistic foragers, they alter their diet and change the location of their preferred feeding sites in response to prey availability (Salt 1976). Suitable badger foraging habitat in Southern Alberta typically corresponds with areas of high concentrations of Richardson's ground squirrels (Michener 2000, Scobie 2002). The habitat requirements of Richardson's ground squirrels are described in Section 4.3, below.

3.3.4 Area Requirements

The badger's home range size in Alberta is unknown, however, studies from the United States indicate that badger home range sizes are variable and change seasonally and by gender (Sargeant and Warner 1972, Lindzey 1978, Scobie 2002). Females tend to be spatially isolated and have smaller home ranges than males (Lindzey 1978, Scobie 2002). Male home ranges typically overlap and may triple in size during the breeding season to maximize access to fertile females (Goodrich and Buskirk 1998, Scobie 2002). In Idaho, home ranges in autumn and winter (Lindzey 1978) were reportedly larger than home ranges during the spring and summer (Messick and Hornocker 1981). Lindzey (1978) reported average home ranges of 583 ha for males and 237 ha for females during autumn and winter. Messick and Hornocker (1981) reported average home ranges of 170 ha for males and 130 ha for females during the spring and summer. In contrast, home range size for a female badger in Minnesota increased greatly from 2 ha in winter to 761 ha in summer, and then decreased to 53 ha in autumn (Sargeant and Warner 1972).

Resident and disperser types of badgers have been identified (Carbyn *et al.* 1999). Dispersers may travel long distances from their natal den and move erratically, whereas residents have established territories that can change in size seasonally depending on food availability.

4 RICHARDSON'S GROUND SQUIRREL

4.1 Background

The Richardson's ground squirrel occurs in the Prairie Provinces in Canada and in Montana, South Dakota, North Dakota, and western Minnesota in the United States (Michener 2002). In Alberta, Richardson's ground squirrels are common and widespread throughout the dry mixedgrass, mixedgrass and fescue prairies (Michener and Schmutz 2002). This species is currently ranked as "Secure" in Alberta; however, there is a paucity of research and documentation of ground squirrel population trends (SRD 2001a). Limited monitoring has been done to assess population numbers or long-term trends at a local or regional scale (Michener and Schmutz 2002). A survey program was initiated in 2003 in the Grasslands Natural Region of Alberta that is expected to determine yearly population trends of this species (Downey 2003a).

The Richardson's ground squirrel are a critical part of the prairie ecosystem as they are an abundant prey species and their burrows provide critical underground refuges for numerous bird, mammal, reptile and insect species (Michener and Schmutz 2002). As discussed previously, Richardson's ground squirrels are among the primary prey consumed by badgers and are also an important prey item for swift fox. Both badgers and swift fox will also excavate and use ground squirrels burrows. Richardson's ground squirrels are a vital prey source for various other species as well, including ferruginous hawks (*Buteo regalis*), Swainson's hawks (*Buteo swaninsoni*), red-tailed hawks (*Buteo jamaicensis*), prairie falcons (*Falco mexicanus*), coyotes, prairie rattlesnakes (*Crotalus viridis*) and long-tailed weasels (*Mustela frenata*) (Michener 2000). Despite their ecological value, ground squirrels are considered "pests" and are routinely poisoned as part of rodent control programs on agricultural lands. Road-kills are another significant cause of human-induced mortality (Gadd 1995). Although ground squirrels have adapted somewhat to human-modified habitats, much of their natural, native prairie habitat has been fragmented or lost to cultivation and development (Michener 2002).

4.2 Ecology

Richardson's ground squirrels are diurnal (active during the day), semi-fossorial mammals that spend the majority of their life underground. Ground squirrels live in clusters of female kin with each female having her own burrow system and rearing her own litter by herself (Saskatchewan Environment and Resource Management (SERM) 2001). In southern Alberta, adult male ground squirrels usually emerge from hibernation in late February to early March, while adult females emerge about two weeks later (Michener 2002). The active season can begin 2 to 3 weeks later in more northerly locations in Alberta and can also vary between years depending on winter severity. Mating begins in the spring after female Richardson's ground squirrels emerge from hibernation (Michener and Schmutz 2002). The gestation period is approximately 23 days (Michener and Schmutz 2002). All litters are usually born within a 1 to 3 week period, and all young squirrels typically emerge at the same time (Michener 2002). Juveniles will appear above ground when they are 28 to 30 days old, in early to mid-May. Litters are usually comprised of 7 to 8 young, but may range from 3 to 11 young (Pattie and Fisher 1999). Young are weaned at one month of age and their growth is rapid throughout the summer. Both males and females are sexually mature at 1 year of age (Michener and Schmutz 2002). Natural mortality is a major factor in regulating population density as less than 1% of males reach 3 years of age and only 40 to 50% of juvenile females survive to adulthood (Michener and Schmutz 2002).

Interestingly, Richardson's ground squirrels spend the majority of their time in hibernation and are only above ground for 15% of their lifetime (Michener and Schmutz 2002). Typically, adult Richardson's grounds squirrels will hibernate for 4 to 8 months. Adult males typically enter hibernation around mid-June to early July, while females go into hibernation in early to late July (Michener 2002). Juveniles remain active until early to mid-August for juvenile females and mid-September to October for juvenile males. During hibernation ground squirrels rely on stored fat to accommodate their metabolic demands (Michener 2000).

4.2.1 Diet

Richardson's ground squirrels are primarily herbivorous, with vegetation (roots, leaves, flowers, and seeds) constituting between 80 to 100% of their total diet (Michener and Schmutz 2002). Ground squirrels eat native vegetation and the seeds and seedlings of forage and cereal crops such as wheat, barley, and oats in agricultural lands (Michener and Schmutz 2002). Richardson's ground squirrels also consume insects and are known to opportunistically scavenge carrion, such as road killed small mammals (Michener and Schmutz 2002).

4.2.2 Predators

During hibernation ground squirrels are safe from most predators with the exception of American badgers. Badgers are the only species that can gain access to ground squirrels within their dens while they are hibernating (Michener 2000, 2002). As hibernating ground squirrels are in a state of torpor and also because of the lack of escape routes in their hibernation system, they make easy prey. During hibernation, as many as 50% of hibernating ground squirrels can be killed by badgers (Michener 2002). As discussed previously, a host of other species prey on Richardson's ground squirrels including numerous raptors, coyotes, and swift fox.

4.3 Habitat Requirements

4.3.1 General

Richardson's ground squirrel colonies typically occur in open, flat, dry, upland grasslands with sufficiently short vegetation to allow them to detect predators from a distance (Michener and Schmutz 2002). Croplands and tall vegetation is considered unsuitable habitat, however, ground squirrels do occur along the edges of cultivation and in ditches (Michener 2002). Ground squirrels are found in greater numbers in flat heavily grazed areas than in taller vegetation (Michener and Schmutz 2002). According to a recent survey along thirty, 8 mile (12.9 km) transects randomly distributed in the Grassland Natural Region of Alberta, significantly more Richardson's ground squirrels were found in native prairie than in modified habitats (Downey 2003b, unpublished survey results). Out of a total of 796 ground squirrels counted during this survey, 571 (72%) were found on native prairie (n=696); 128 (16%) were found in cultivation (n=808); 58 (7%) in seeded pasture (n=141); 32 (4%) in irrigated hay land (n=15); and 7 (0.9 %) in farmyards (n=24). The majority of ground squirrels found in native prairie were in short vegetation (less than 10 cm).

The habitat suitability index (HSI) model for Richardson's ground squirrels in the Milk River Basin included three, equally weighted variables: grassland coverage, slope, and soil texture (Downey 2004b). Quarter sections with at least 20% graminoid cover, slopes up to 10 degrees, and with moderately coarse (sandy loam) or medium (loam, silt- loam, or silt) soils were rated as optimum ground squirrel habitat.

4.3.2 Denning Habitat

Laundré and Appel (1986) found that Richardson's ground squirrel burrow sites in southwestern Minnesota were preferentially located in short vegetation (5 cm or less) and moderately well drained soils. Short vegetation is thought to be important not only for predator detection but also for social communication involving visual cues (Laundré and Appel 1986, Michener and Schmutz 2002). Suitable soils with sufficient drainage are important to prevent burrows from flooding, to ensure ease of digging, and to maintain the structural integrity of burrows (Laundré and Appel 1986, Michener and Schmutz 2002). In Alberta, ground squirrels tend to prefer sandy and well-drained soils and typically avoid loose sand or heavy clay soils (Reynolds *et al.* 1999).

Burrows of Richardson's ground squirrels are quite intricate with several secondary entrances and "plunge" holes (Pattie and Fisher 1999). "Plunge" holes are inconspicuous entrances that are used for quick escapes (Gadd 1995). A main burrow chamber may be 4 to 10 meters in length and usually ends in a grass lined nest chamber (Michener 2002). Burrows can extend up to 1.8 m in depth (SERM 2001).

4.3.3 Foraging Habitat

Richardson's ground squirrels typically forage near to their burrows to ensure quick escape from predators. Therefore, sites that are suitable for burrowing, as described above, are also used for foraging. As ground squirrels have a broad diet and consume a variety of native and non-native plants, short vegetation height is considered more important than species composition in determining suitable foraging habitat (Michener and Schmutz 2002). However, as noted by Michener and Schmutz (2002), more information is needed about the natural diet and foraging preferences of Richardson's grounds squirrels in Alberta.

4.3.4 Area Requirements

Home ranges for female ground squirrels may be up to 240 m^2 in size in the summer, however, they tend to spend the majority of their time in core areas of 20 to 40 m^2 (Michener 2002). Female relatives may have overlapping home ranges (Michener 2002). Female home range sizes tend to increase until early summer and subsequently decrease closer to the hibernation period (Michener 2002). Male home ranges also fluctuate and typically increase up to mating and then decrease substantially (Michener 2002). During the breeding season, male home ranges can overlap the areas used by as many as 10 females (Michener 2002).

5 GRAZING AND BURROWING MAMMALS

There have been few quantitative studies that have assessed how cattle grazing or selective grazing systems affect swift fox, badgers, or Richardson's ground squirrels in Alberta or across their range in North America. However, based on their ecological requirements, grazing appears to be necessary for maintaining suitable habitat for these species or their prey.

5.1 Swift Fox Response to Grazing

Open, unobstructed areas with short vegetation are considered important to swift foxes to enable them to catch prey efficiently and avoid predation (Smeeton pers. comm.). Foxes are built for speed, and in open areas can reach speeds of over 50 kilometers per hour (FWD 1990). Given their small size, taller vegetation impedes their natural running stride (Smeeton pers. comm.). Therefore, grazing is considered important for maintaining suitable habitat for this species (Smeeton pers. comm.). However, the benefits of grazing to swift fox depend in particular on the effects of grazing on winter prey availability (Carbyn 1989, Moehrenschlager pers. comm.). Although food is not considered limiting to swift fox during the summer months, availability of small mammal prey during the winter is critical to their survival (Carbyn 1989). Heavy grazing has been shown to negatively affect rodent species diversity in arid regions and has been correlated with declines in the kit fox (*Vulpes macrotis*) in the United States (Rosenzweig and Winakur 1969, Brechtel *et al.* 1996). Heavy grazing is thought to be particularly detrimental to most vole species which tend to prefer areas with sufficient canopy cover (Fagerstone and Ramey 1996). Sufficient vegetation cover is particularly important to voles during winters with limited snow cover (Moehrenschlager pers. comm.). Therefore, heavy grazing over large areas may be detrimental to swift fox if it reduces prey availability during the winter months (Brechtel *et al.* 1996, Moehrenschlager pers. comm.). Since swift fox are nocturnal, heavy grazing systems that favour diurnal prey species may also be detrimental to foxes as hungry foxes would hunt whenever prey is available, increasing their vulnerability to predation (Carbyn 1989).

Heavy grazing over large areas may not only be detrimental in terms of reducing winter prey availability, but may also negatively affect availability of preferred swift fox breeding sites. Recent studies in Alberta, Saskatchewan, and South Dakota indicate that swift fox breeding dens are preferentially placed in areas with taller grass potentially due to improved hiding and screening cover (Pruss 1999, Uresk *et al.* 2003). A patchy environment with areas of variable degrees of grazing intensity is therefore considered more appropriate for maintaining swift fox habitat (Carbyn 1989). Smaller, heavily grazed patches offer suitable swift fox foraging habitat, while light to moderately grazed patches provide denning cover and refuge habitat for their small mammal prey. This type of vegetation patchiness was thought to have been promoted by former bison grazing regimes (Carbyn 1989).

5.2 American Badger Response to Grazing

Few studies have examined the interaction between livestock grazing and badgers. However, it could be assumed that grazing practices that benefit their principal prey (*i.e.*, Richardson's ground squirrels and northern pocket gophers), will also benefit the badger. Although heavy to moderate grazing promotes suitable habitat for Richardson's ground squirrels, northern pocket gophers, in contrast, are attracted to rangeland in good condition with vigorous plants (Fagerstone and Ramey 1996). Pocket gopher densities have been correlated with plant biomass, with higher densities of gophers in fields with the greatest biomass and a high proportion of forbs (Fagerstone and Ramey 1996). Several studies have found higher pocket gopher numbers on ungrazed areas (Fagerstone and Ramey 1996). Therefore, grazing systems that promote vegetation patchiness with some areas that are heavily grazed and other areas that are lightly grazed will likely benefit both of the badger's primary prey populations. This type of system will also encourage habitat for a diversity of other suitable small mammal prey (Fagerstone and Ramey 1996).

To refine grazing recommendations in relation to badgers, studies need to define the vegetation structure preferred by badgers at natal (breeding) dens. Furthermore, studies should evaluate threshold densities of ground squirrels and pocket gophers that are needed to maintain a viable population of badgers.

As with ground squirrels, encouraging tolerance towards badgers by ranchers requires a cost-benefit analysis approach. The benefits of badgers as a free, biological control agent for maintaining reduced ground squirrel populations should be weighed against the actual costs incurred due to injured livestock or damaged machinery from badger burrows and the costs of badger control efforts. Badger burrowing activity also has ecological benefits to numerous other fauna and has soil aeration and water penetration benefits that should be considered (Scobie 2002).

5.3 Richardson's Ground Squirrel Response to Grazing

Moderate to heavy grazing is considered especially beneficial to Richardson's ground squirrels, which rarely colonize areas with tall, dense vegetation (Fagerstone and Ramey 1996, Michener pers. comm.). Richardson's ground squirrels require shorter vegetation ($\leq$10 cm) to easily detect predators and for social communication, and occur in greater numbers in shorter vegetation habitats (Laundré and Appel 1986, Michener and Schmutz 2002). Therefore, rangelands in fair to poor condition characterized by secondary succession plants and low vegetation are considered capable of supporting high densities of Richardson's ground squirrels (Fagerstone and Ramey 1996). The degree of grazing required to create or to maintain suitable habitat for ground squirrels varies depending on vegetation type and moisture regime (Fagerstone and Ramey 1996). For example, moderate to heavy grazing may be required to open up habitat for Richardson's ground squirrels in productive mixedgrass or fescue prairie, whereas light grazing may be sufficient to maintain suitable habitat for ground squirrels in dry mixedgrass prairie with lower productivity and vigour and during drought conditions.

At high densities Richardson's ground squirrels may potentially compete with cattle for forage resources due to the high amount of graminoids they consume (Fagerstone and Ramey 1996). However, the damage potential of Richardson's ground squirrels is often over-estimated and requires further research (Michener and Schmutz 2002). Given their small size and the fact that they are only active for a restricted period of the year, Michener and Schmutz (2002) estimated that it takes 2, 275 ground squirrels to equal the forage intake of one adult cow. Furthermore, research indicates that only 4 to 7% competition occurs between a similar ground dwelling rodent, prairie dogs (*Cynomys* spp.), and livestock (Miller *et al.* 1994, Michener and Schmutz 2002). Other studies have found no significant difference in the market weight of steers that have lived with or without prairie dogs (Miller *et al.* 1994). Therefore, Michener and Schmutz (2002) caution that managers should conduct an adequate cost-benefit analysis to assess how much time, energy and money should be invested to control ground squirrels that will ensure an appropriate return on their investment. This requires a scientific or economic study to establish (i) the degree of forage competition between cattle and ground squirrels; (ii) the extent of pasture damage caused by ground squirrels; and (iii) the frequency with which livestock are injured as a result of ground squirrel burrowing activity (Michener and Schmutz 2002). The ecological benefits of ground squirrels should also be considered in this analysis, including their role as a fundamental prey species and the benefits of their burrowing activities to other fauna. The benefits of ground squirrel burrowing activities also includes reducing soil compaction, and promoting soil aeration, nutrient cycling and soil development (Fagerstone and Ramey 1996). The potential for ground squirrels to improve forage quality for cattle at colony sites, and selective grazing by cattle at colony sites should also be investigated (Coppock *et al.* 1983). Koford (1958) suggested that there was a reciprocal ecological relationship between bison and prairie dogs, whereby each maintained ideal habitat for the other, comprised of shortgrass species interspersed with patches of forbs and bare ground. Coppock *et al.* (1983) confirmed that bison fed selectively on moderately grazed, grass-dominated areas near the perimeters of prairie dog colonies, despite the fact that maximum plant biomass occurred on uncolonized sites. Bison were attracted to graze near prairie dog colonies as these areas had more readily digestible vegetation with higher crude protein and less dead vegetation and greater accessibility of green tissues than vegetation from uncolonized areas (Coppock *et al.* 1983).

Where ground squirrel population control is considered necessary, control strategies other than conventional poisoning programs have been suggested that will not detrimentally impact non-target species such as swift fox (Michener and Schmutz 2002). One strategy suggested for prairie dogs and ground squirrels is to use deferred grazing or reduced stocking rates to encourage greater areas of taller and denser vegetation (Fagerstone and Ramey 1996, Michener and Schmutz 2002). Greater vegetative cover can make an area less suitable or less attractive to ground squirrels and may therefore provide a long-term method of improving rangeland productivity and maintaining ground squirrel populations at acceptable levels (Michener and Schmutz 2002). Establishing stocking rates and controlling the distribution and extent of moderate to heavily grazed areas can therefore be used as tools to manage availability of suitable ground squirrel habitat. Promoting raptors or badgers as natural biological control agents is another strategy (Michener and Schmutz 2002). Determining acceptable ground squirrel population densities should account for the necessary abundance of ground squirrels needed to support a specified predator composition and abundance.

6 LIVESTOCK GRAZING SYSTEMS AND SWIFT FOX, AMERICAN BADGER AND RICHARDSON'S GROUND SQUIRREL HABITAT MANAGEMENT

Table III-9 provides an overview of five grazing systems and their potential positive and negative implications for maintaining or enhancing habitat for swift fox, American badgers and Richardson's ground squirrels. A grazing system is a tool used to control the spatial distribution, timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003). Applied research is needed to properly assess the effectiveness of various grazing systems for providing habitat for these species in the Milk River Basin.

Table III-9 Grazing Systems and Swift Fox, Badger and Richardson's Ground Squirrel Habitat Management

Grazing System	Discussion
Continuous (Season-long) Grazing	
Advantages:	Under a continuous grazing system, cattle have use of the entire pasture. The primary means of controlling the effects of grazing in this type of system involve setting stocking rates; utilizing water, salt or mineral placement and / or herding to distribute cattle; and controlling entry and exit dates. Under light to moderate stocking rates cattle will not utilize the full extent of the rangeland and a certain percentage of vegetation carryover will be retained. Areas of intense grazing pressure will be concentrated near water or salt or in patches with more palatable grasses. Formerly grazed patches will receive repeated use as these patches have a lesser build up of litter and higher cover of more palatable regrowth vegetation (Robertson *et al.*1991). Other areas of the rangeland will receive moderate, light, or no use depending on the palatability of forage, terrain, and distance to stockwater. Hence, conservative stocking rates can encourage patchiness with areas with heterogeneous amounts of use having variable structural and plant species composition characteristics. Richardson's ground squirrels are most likely to occur in highest densities in areas that receive the most use and in formerly heavily grazed patches or disturbance areas (Michener 2002). Northern pocket gophers and voles, in contrast, are more likely to occur in areas with greater vegetation cover (Fagerstone and Ramey 1996). Vegetation heterogeneity as stimulated by variable grazing intensity is therefore important for promoting small mammal prey diversity for badgers and swift fox (Steenbergh and Warren 1977 as cited in Fagerstone and Ramey 1996, Jones *et al.* 2003). A diverse prey base is likely to provide a more stable food supply for predators during periods of drought or severe winters and given the cyclic nature of many small mammal populations. Moderate grazing also stimulates plant species diversity which has been positively correlated with increasing the diversity and richness of arthropod species (Willoughby 1993, Jonas *et al.* 2002). Arthropods provide an alternate important prey base for swift fox during the summer and autumn periods. Variable vegetation heights and density across the rangeland is also important for promoting suitable denning areas for swift fox with sufficient cover (Pruss 1999, Uresk *et al*. 2003).
Disadvantages:	Continuous grazing systems that are intensively stocked will promote large areas of short and relatively uniform vegetation characteristics, depending on the grassland community and local terrain. Under heavy stocking rates grazing becomes less selective, resulting in all plant groups and not only favoured forage species being grazed. Heavy stocking rates also results in a substantial reduction in carryover of litter material. These conditions will likely favour high densities of Richardson's ground squirrels and provide an ample prey base for badgers in particular. However, over time, consistent heavy grazing has been found to reduce small mammal species diversity overall and to depress populations of most small mammals (Fagerstone and Ramey 1996). This may have a negative effect

Grazing System	Discussion
Continuous (Season-long) Grazing Cont'd.	
Disadvantages:	on availability of microtine prey for swift fox during the winter months (Brechtel *et al.* 1996). The effect of heavy grazing on small mammal populations depends on the type of grassland and the small mammal species affected (Fagerstone and Ramey 1996). For example, grazing has been demonstrated to have a more profound effect on small mammals in tallgrass prairie than in shortgrass prairie, where plant cover is already low (Fagerstone and Ramey 1996). The effect of continuous grazing systems with high stocking rates on swift fox and badger denning habitat requires further research. Based on results presented by Pruss (1999) and Uresk *et al.* (2003) this type of grazing regime may reduce the height and density of vegetation preferred at swift fox dens.
Complementary Grazing	
Advantages:	Complementary grazing has the potential to benefit the stability and diversity of the small mammal prey base available to swift fox and badgers by allowing for deferred use and improved condition of native prairie. Deferred use of native prairie is permitted due to early season grazing on seeded pasture. With deferred use, native prairie vegetation cover and density may be improved which then has the potential to increase rodent species abundance and diversity (Steenbergh and Warren 1977 as cited in Fagerstone and Ramey 1996). Skinner *et al.* (1996) reported that deferred grazed native grasslands that were part of the Medicine Wheel Project in southeastern Alberta, had the highest values for vegetative cover and were the most productive habitat type for small mammals. Seeded pastures also offer suitable habitat for certain rodents such as deer mice. Skinner *et al.* (1996) reported that small mammal abundance (primarily deer mouse abundance) was three times greater in seeded pasture than in native prairie under various rotational grazing strategies. Deer mice commonly travel above the snow during the winter and thus provide a suitable winter prey source for swift foxes (Pattie and Fisher 1999).
Disadvantages:	Unless heavily grazed, the taller growth habitat of most seeded pasture forage species such as smooth brome (*Bromus inermis*) or timothy grass (*Phleum pratense*) creates unsuitable habitat for swift fox and Richardson's ground squirrels. In general, Richardson's ground squirrels, swift fox and badgers occur more commonly in native prairie habitats than seeded pasture or cropland (Cotterill 1997, Michener 2002, Scobie 2002, Downey 2003b, unpublished survey results). Therefore, the benefits of complementary grazing depend on whether marginal cropland can be converted to seeded pasture or if seeded pasture is available within the grazing operation.
Rotational Grazing	
Advantages:	Rotational grazing systems are often considered advantageous to wildlife as they allow for controlled, periodic rest and recovery of the rangeland. MacCracken *et al.* (1985) reported a significant positive relationship between small mammal abundance and cover in sagebrush-grass rangeland in Montana, where all areas were managed under a rest-rotational grazing system. Under a rest-rotational system, those fields that receive a full season of rest will likely become less suitable for Richardson's ground squirrels, which will be encouraged to disperse into more recently grazed fields. By encouraging areas of recovered vegetation cover and density this type of grazing strategy can thereby offer a means to control ground squirrel density and dispersion. As mentioned previously, overall rodent abundance and diversity has been found to increase with increased vegetation cover and density (Steenbergh and Warren 1977 as cited in Fagerstone and Ramey 1996). Therefore, the overall effect of rotational grazing could increase the diversity and possible stability of the swift fox and badger small mammal prey base. Rotational grazing systems, by portioning cattle into smaller management units, also offers a means to distribute grazing use over a wider area. An overall reduction of vegetation height over a larger area improves habitat suitability for Richardson's ground squirrels and may offer favourable foraging habitat for swift fox.

Grazing System	**Discussion**
Rotational Grazing Cont'd.	
Disadvantages:	Vegetation heterogeneity promoted by rotational grazing systems can be reduced if cattle are grazed beyond the 50% utilization point (Kobriger 1980). More uniform use of a greater area diminishes refuge habitat for voles and northern pocket gophers in particular, important swift fox and badger prey items (Fagerstone and Ramey 1996). Uniform heavy use, however, could promote higher densities of Richardson's ground squirrels (Michener 2002).
Intensive Grazing	
Advantages:	Intensive grazing for short periods opens up habitat for Richardson's ground squirrels, particularly in areas with taller grass cover or high build up of standing dead litter. High densities of Richardson's ground squirrels offers an abundant food source for badgers in particular.
Disadvantages:	High densities of Richardson's ground squirrels may result in greater forage competition between ground squirrels and cattle, potentially increased incidence of injury due to greater numbers of burrows, and an overall depletion in rangeland productivity. Higher densities of a perceived rodent competitor often prompt managers to resort to poisoning population control tactics. Swift fox, badgers, and numerous other predators can be negatively affected by consuming poisoned ground squirrels or poisoned bait. Consistent heavy grazing over time has also been found to reduce the overall abundance and diversity of small mammals in an area (Fagerstone and Ramey 1996). This has negative implications, as discussed, for reducing badger and swift fox prey availability and stability, particularly during the winter.
Riparian Area Grazing	
Advantages:	All of the species considered in this report are associated with open, flat, dry, upland grasslands. Riparian area grazing systems, therefore, may not have a significant effect on ground squirrels, swift fox, or badgers. However, as productive riparian areas often harbour rich populations of insects and small mammals these areas may serve as important source habitats for swift fox or badger prey to disperse from (Strand and Merritt 1999). Studies have shown that small mammals in riparian habitats can be significantly detrimentally impacted by heavy grazing due to a loss of vegetative cover (Fagerstone and Ramey 1996). Riparian area grazing systems can benefit retention or improved vegetation cover in these areas and thereby serve to increase small mammal population sources.
Disadvantages:	Riparian area grazing systems attempt to reduce the amount of time cattle spend along riparian corridors or control timing of use of riparian areas. This can result in a greater impact to upland grasslands and may diminish habitat opportunities for voles or northern pocket gophers in these areas.

7 BENEFICIAL MANAGEMENT PRACTICE RECOMMENDATIONS

Reestablishment of stable swift fox populations in the Milk River Basin is partially dependent on protection and appropriate management of native prairie rangelands using cattle grazing as a habitat enhancement tool. Management practices designed to benefit swift fox need to consider the ecological importance of maintaining badger and Richardson's ground squirrel populations and their associated burrows as well as maintaining sufficient densities of other small mammal prey.

The following general land use and grazing recommendations offer a variety of means to protect or enhance swift fox, badger and Richardson's ground squirrel habitat within the Milk River Basin and throughout the Grassland Natural Region of Alberta. Further research (Section 8) is required to improve our understanding of these species and their habitat requirements as well as their response to grazing and various grazing management practices.

7.1 General Recommendations

- Protect remaining native prairie from cultivation. Protection of large tracts of native dry mixedgrass and mixedgrass prairie from cultivation is considered especially critical for maintaining suitable habitat for swift fox (Brechtel *et al.* 1996).
- Remove marginal cropland from production, where possible, and seed with native, mixedgrass or dry mixedgrass graminoids to enlarge suitable habitat for Richardson's ground squirrels, badgers and swift fox.
- Discourage the use of poisoning programs to control high densities of Richardson's ground squirrels. These types of programs negatively affect both swift fox and badgers due to direct poisoning or reduced prey availability (FWD 1990, Brechtel *et al.* 1996, Scobie 2002). Encourage alternative ground squirrel population control strategies such as promoting badgers or other natural predators like raptors as biological control agents. Investigate vegetation management techniques, such as retaining greater amounts of taller and denser vegetation cover to manage ground squirrel populations at appropriate densities (Michener and Schmutz 2002).
- Given the reliance by swift fox on badger burrows, direct hunting, trapping or poisoning of this species has potential to limit the availability of suitable denning burrows for swift fox. Fewer available burrows reduces predator escape habitat for swift fox and lowers the quality or suitability of an area for swift fox.
- Promote organic farming practices and discourage the use of pesticides or herbicides on seeded pastures or cropland in the vicinity of swift fox dens (Cotterill 1997). Pesticides can reduce the availability of insect or rodent prey or result in bioaccumulation of toxins in prey species (FWD 1990, Cotterill 1997). Furthermore, contaminated prey may affect fox reproductive success and survival (Cotterill 1997).
- Abide by setback distances and timing restrictions recommended by SRD, Fish and Wildlife Division for human activities, including industrial development near to swift fox breeding dens (SRD 2001b). SRD recommends a year-round setback of 500 m from swift fox dens for high impact developments such as wellsites, powerlines and pipelines.

- Conduct pre-development wildlife surveys to locate swift fox dens in areas with suitable habitat or known swift fox populations.
- Inform landowners and managers about the ecological importance of badgers and Richardson's ground squirrels.
- Offer incentives to landowners for maintaining swift fox populations.

7.2 Grazing Recommendations

Livestock grazing as a land use is compatible with protection of large tracts of native prairie and can be used to mimic patterns of disturbance that would have existed under historical bison grazing regimes. Swift fox, badgers and Richardson's ground squirrels all coexisted with bison grazers on the Great Plains of North America prior to European settlement (Carbyn 1989, Fagerstone and Ramey 1996, Scobie 2002). Bison grazing patterns are thought to have stimulated a patchy environment with some areas of intensive grazing, and other areas of light or no grazing (Carbyn 1989, Adams *et al.* 1994). This patchiness is thought to be beneficial for stimulating small mammal abundance and species diversity by creating a variety of micro-habitats for species with varying cover requirements (Fagerstone and Ramey 1996).

In order to refine grazing management recommendations for individual grazing operations, local ecological conditions and defined wildlife management and livestock production objectives need to be taken into account. Ecological conditions include factors such as vegetation type, terrain, grazing history and small mammal community composition. Management objectives include defining tolerable Richardson's ground squirrel densities that will not jeopardize rangeland productivity but will also sustain a desired predator population density. Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

The following recommendations provide general goals for maintaining habitat for swift fox, badgers and Richardson's ground squirrels while also maintaining rangeland productivity:

- Promote patch grazing and heterogeneous vegetation heights, with areas of heavy, moderate, light and no use. This will ensure that patches of shorter vegetation are maintained to sustain ground squirrel populations, while also retaining patches of taller vegetation to support microtine (vole) rodent populations and northern pocket gophers. Voles are an important winter prey species for swift fox (Carbyn 1995, Brechtel *et al.* 1996), while northern pocket gophers are the second most important badger prey in Alberta (Scobie 2002).
- In a continuous grazing system, light to moderate grazing at suitable proper use factors for fescue (40%) and mixed grass prairie (50%) can be used to prevent uniform utilization of the range and to promote patchy grazing (Adams *et al.* 1994).
- To promote vegetation patchiness on a field basis, use rotational grazing systems or complementary grazing as a means to control timing, rest frequency and intensity of use in each field. Promote heavier grazing use in seeded pastures rather than native prairie. Seeded

forage species usually have a taller growth habit that is limiting to swift fox and ground squirrels.

- Use deferred or rest-rotational grazing to allow for improved vegetative cover in areas where ground squirrel densities exceed tolerable thresholds (Michener and Schmutz 2002). Encouraging increased vegetation cover will reduce habitat suitability for ground squirrels.
- In areas where swift fox occur, avoid intensive grazing systems with high density stocking rates over large areas. Manage for average vegetation heights of approximately 12 cm at preferred den and foraging sites (Uresk *et al.* 2003).
- Use upland stockwater development or salt placement as tools to encourage better distribution of cattle over the landscape and to create controlled, predetermined areas with heavier use.
- Adjust stocking rates during drought conditions. Depending on past use, vegetation type, productivity and vigour, light grazing may be sufficient to maintain suitably short vegetation for Richardson's ground squirrels and swift fox.

8 RESEARCH RECOMMENDATIONS

Few studies have researched the effects of grazing or selective grazing systems on swift fox, badgers, or their key prey species including Richardson's ground squirrels. To assist managers in refining beneficial management practices, research is needed to determine which grazing systems are best suited to sustaining viable populations of these species while also maintaining sustained rangeland productivity. In addition to this type of research, information is also needed to better define the population trends, habitat requirements, and foraging habits of each of these species. Key research needs are described below for each species.

8.1 Swift Fox

- Conduct an assessment of the effects of variation in yearly and seasonal precipitation and temperature on swift fox prey base and microhabitat selection (Uresk *et al.* 2003).
- Define the characteristics and seasonal variation of swift fox foraging habitat and microhabitat selection in Alberta and Saskatchewan.
- Conduct an evaluation of swift fox movement patterns, behaviour, and food habits in southern Alberta during the winter.
- Evaluate the vegetation structure and plant species composition of preferred winter foraging areas.
- Evaluate the effect of snow depth on selection of winter foraging sites.
- Determine the effects of different grazing regimes on the abundance and availability of important winter prey species utilized by swift fox (Brechtel *et al.* 1996).
- Evaluate the effect of grazing intensity and duration on selection of preferred foraging sites in various seasons.
- Conduct additional research to quantify home range sizes and juvenile dispersal distances for swift fox in Alberta and Saskatchewan under various grazing regimes and in varying conditions of native prairie.

- Evaluate swift fox use of seeded pastures versus native grassland in varying range conditions.
- Investigate the suitability of silver sagebrush grasslands as swift fox habitat in southern Alberta (Olson and Lindzey 2002a).
- Determine Richardson's ground squirrel and badger densities in preferred swift fox habitats. Investigate whether high ground squirrel densities results in higher local predator populations and consequently higher predator-induced mortality among swift fox.

8.2 American Badger

- Initiate a badger population monitoring program in the Milk River Basin and throughout the Grasslands Natural Region of Alberta to better define population sizes and trends.
- Conduct further research to determine badger home range sizes in Alberta and determine the influence of ground squirrel density, range condition, and grazing intensity on variation in home range sizes.
- Determine relative badger abundance in pastures managed under various grazing systems and in various range condition types.
- Determine Richardson's ground squirrel population densities that are required to sustain a specified number of badgers.
- Evaluate the vegetation structure characteristics at badger breeding dens.
- Conduct a cost-benefit analysis to determine the actual costs of badger burrows to ranchers. Factor into this analysis the benefits badgers offer as ground squirrel predators, as well as the importance of their burrows to endangered species.

8.3 Richardson's Ground Squirrel

- Continue the Richardson's ground squirrel monitoring program in the Grassland Natural Region of Alberta to determine long-term ground squirrel population trends and habitat preferences (Downey 2003a). Attempt to determine the primary causal factors that are responsible for large-scale fluctuations in ground squirrel populations.
- Determine the level of grazing that is required to create favourable habitat for ground squirrels in dry mixedgrass, mixedgrass and fescue prairie under various moisture regimes and range condition classes.
- Compare ground squirrel populations in similar grassland types with variable intensities of grazing including areas that are ungrazed.
- Determine the amount and type of forage consumed by ground squirrels and the potential for competition between cattle and ground squirrels (Michener and Schmutz 2002). Calculate the potential for ground squirrel herbivory to impact cattle weight gains.
- Determine the effect of ground squirrel herbivory on plant species composition and overall rangeland productivity.
- Assess cattle foraging behaviour in areas where ground squirrels occur to determine whether cattle selectively graze near ground squirrel colonies (Coppock *et al.* 1983).
- Assess whether ground squirrel herbivory improves the palatability or quality of forage available to cattle.
- Conduct a broad assessment of the impact of ground squirrel poisoning programs on non-target avian and mammal species.

- Carry-out a cost-benefit analysis to determine the amount of energy and money that should be invested in ground squirrel control relative to recolonization rates, and actual costs due to forage competition or burrow-induced injuries to cattle (Michener and Schmutz 2002).
- Compare the effectiveness of natural predators as ground squirrel population control agents versus poison application.
- Determine tolerable ground squirrel densities from a joint wildlife management and agricultural land use management perspective.

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C. MULE DEER AND WHITE-TAILED DEER

1 INTRODUCTION

1.1 Background

The purpose of this report is to summarize the ecology and habitat requirements of mule (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*) in southern Alberta in general, and more specifically within the Milk River Basin. Inter-specific competition between deer species as well as the interaction and response of deer to livestock grazing is discussed. Grazing management systems and range improvements that may be used to enhance deer habitat are then reviewed and a summary of recommended beneficial management practices to manage deer habitat is provided. The recommendations apply to the Milk River Basin and to the greater Grassland Natural Region of Alberta. Lastly, a summary of research recommendations is given.

Mule deer and white-tailed deer in the Milk River Basin are economically important as big-game species for recreational hunters (Alberta Fish and Wildlife Division (FWD) 1989, Alberta Environmental Protection (AEP) 1995). Deer populations are regularly monitored in Alberta and hunting is controlled through season length and bag limits, sex restrictions and zoning (FWD 1989, AEP 1995). Managing deer populations effectively also requires an understanding of their habitat requirements and habitat enhancement strategies. Since deer coexist with livestock throughout much of their range, several studies have attempted to examine how cattle grazing influences deer foraging behaviour as well as how it can be used as a tool to enhance deer habitat (Holechek *et al.* 1982, Kie *et al.* 1991, Loft *et al.* 1991, Telfer 1994). Livestock grazing has the potential to affect deer habitat by altering vegetation composition, productivity, nutritive quality, and structure (Severson and Urness 1994).

Mule and white-tailed deer are most abundant in the prairies and parklands of Alberta, but are common throughout much of the province (FWD 1989, AEP 1995). Populations of both species declined to very low levels in the late 1800's due to severe winters and high hunter harvest levels (FWD 1989, AEP 1995). In the 1900's the numbers recovered, peaking in the 1950's, then declining again in the 1960's and early 1970's (FWD 1989, AEP 1995). Both mule and white-tail deer populations within the Milk River Basin have experienced an increase in recent years (FWD 1989, AEP 1995, Erickson 2002, Taggart pers. comm.). A series of mild winters and conservative harvest regimes are cited as the primary factors for recent population increases (FWD 1989, AEP 1995).

Aerial winter surveys are conducted either annually or on a rotational basis to monitor mule and white-tailed deer populations in various Wildlife Management Units (WMUs) in southern Alberta (Dube pers. comm.). The Milk River Basin occupies all or a portion of WMUs 102, 104, 106, 108 and 118 (FWD 1989, AEP 1995). Survey information is used to calculate pre-season (*i.e.*, fall) population estimates for each WMU annually. The combined 2003 pre-season population estimate for these WMUs was 10,568 mule deer and 4,759 white-tailed deer (Quinlan pers. comm.). Mule and white-tailed deer are presently listed as "Secure" species in Alberta with stable populations and secure habitat (Alberta Sustainable Resource Development (SRD) 2001).

1.2 Ecology

1.2.1 Breeding

The breeding (rutting) season for deer in Alberta usually occurs between late October and early December (Van Tighem 2001). Deer do not form harems as elk do; however, a successful, typically older, buck may impregnate several females during the mating season (Van Tighem 2001). Fawns are usually born in May or early June. The gestation period lasts approximately 6.5 to 7 months (Pattie and Fisher 1999, Van Tighem 2001). Does on average give birth to 2 fawns or twins but may produce 1 to 3 young (Pattie and Fisher 1999). Yearling does and does on poor range may produce single fawns (Pattie and Fisher 1999). Age at first parturition may be as early as 1 year if on good range, but 2 years is more common (Van Tighem 2001). Females are seasonally polyestrous (Peek and Krausman 1996, Teer 1996). A doe can undertake up to 4 cycles in a breeding season as the estrous cycle is repeated every 28 days, although they usually conceive in their first heat. Fawns are most often weaned at 4 to 5 months old (Peek and Krausman 1996, Teer 1996). A doe and fawn will typically stay together until the next spring. Due to the overlapping ranges of mule deer and white-tailed deer in Alberta, hybrids have been observed (FWD 1989, AEP 1995). The survivability and fertility of hybrids is generally considered inferior to non-hybrids (AEP 1995, Van Tighem 2001). Hybrids in Alberta associate mainly with mule deer (FWD 1989). Deer may live up to 20 years, however most live less than 10 years (Peek and Krausman 1996, Teer 1996).

1.2.2 Diet

White-tailed and mule deer diets overlap considerably in Alberta (FWD 1989, AEP 1995). The winter and summer diets of deer tend to differ in composition (Gadd 1995, Pattie and Fisher 1999, Wood *et al.* 1999). In fall and throughout winter, deer browse on the leaves and twigs of shrubs, willows, and aspen trees (FWD 1989, AEP 1995, Pattie and Fisher 1999, Wood *et al.* 1999). Forbs and grasses make up a substantial part of the spring and summer diet (Wood *et al.* 1999). There is typically an energy surplus available to deer for synthesis and storage of fat during the summer, and an energy deficit during the winter (Wallmo *et al.* 1977). Winter forages contain less of the digestible components such as proteins, starches, and sugars than summer forage (Wallmo *et al.* 1977).

Common winter forb and browse species consumed by white-tailed and mule deer in Alberta include: asters (*Aster* spp.); snowberry (*Symphoricarpos albus*, *S. occidentalis*); aspen (*Populus tremuloides*); rose (*Rosa* spp.); saskatoon (*Amelanchier alnifolia*); choke cherry (*Prunus virginiana*); willow (*Salix* spp.); silverberry (*Elaeagnus commutata*); and creeping juniper (*Juniperus horizontalis*) (Rhude and Hall 1977, FWD 1989, AEP 1995). Other important winter forb species for white-tailed deer include peavines (*Lathyrus* spp.) and horsetails (*Equisetum* spp.) (AEP 1995). Pasture sagewort (*Artemisia frigida*) has been identified as an important component of the mule deer winter diet in Alberta (FWD 1989). Both mule and white-tailed deer will also eat agricultural crops such as alfalfa (*Medicago sativa*), winter wheat (*Triticum* spp.), fall rye (*Secale cereale*), oats (*Avena sativa*) and barley (*Hordeum* spp.) particularly during the fall and spring (FWD 1989, AEP 1995). Bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), oatgrass (*Danthonia intermedia*), and ricegrass (*Oryzopsis hymenoides*) are examples of grasses that are rated as good to excellent native forage for mule deer during the spring and summer (Peek and Krausman 1996). Of the common introduced forage grasses, timothy (*Phleum pratense*) provides good to excellent mule deer forage, while crested wheatgrass (*Agropyron pectiniforme*) is rated as fair (Peek and Krausman 1996).

In comparison to other cervids (members of the Deer Family) such as sheep, goats or elk, deer tend to be more selective in their forage and therefore have a smaller food base (Collins and Urness 1983). Deer have a lower digestive efficiency and are less capable of efficiently digesting the lignified fiber of non-preferred grasses and sedges. Consequently, deer may be less successful at competing with other cervids on poor condition range (Collins and Urness 1983).

1.2.3 Predator Response

Primary deer predators include coyotes, cougars and humans (Van Tighem 2001). White-tailed deer and mule deer respond somewhat differently to predators (Lingle 2002). Mule deer are more adapted to open areas near steep terrain and tend to elude predators by moving to and up slopes (Van Tighem 2001, Lingle 2002). White-tailed deer appear to be more adapted to gentler terrain and rely on their greater speed and proximity to dense cover to evade predators (Van Tighem 2001, Lingle 2002). Unlike mule deer, white-tailed deer tend to move down and away from slopes toward cover when confronted by predators (Lingle 2002). The formation of herds is thought to be another adaptation to predation and is common to both species (Van Tighem 2001). Predators such as coyotes, for example, are more likely to attack and kill an individual deer when herds split and individuals become isolated (Lingle 2003). In Southeastern Alberta, Lingle (2003) found that mule deer formed larger more cohesive mixed-sex groups during the winter than white-tailed deer. Lingle (2003) suggests that herding may be more important as an antipredator strategy for mule deer than for white-tailed deer as they are slower and less effective at fleeing from predators than white-tailed deer.

1.2.4 Movement Patterns and Herding

Mule and white-tailed deer both tend to move between winter and summer ranges (Kramer 1971a, Van Tighem 2001). In general, white-tailed deer in the prairies are considered less ‘migratory’ than mule deer and often occur in the same area year-round if conditions are suitable (Van Tighem 2001). Movements in winter are associated with access to better thermal cover and more accessible food resources (FWD 1989). Winter ranges for deer in the Milk River Basin are more discrete than summer ranges. Seasonal deer movements vary in response to snow cover, temperature, access to food resources, and human disturbance (FWD 1989, AEP 1995, Van Tighem 2001).

Mixed herds of does and bucks come together during the rut in the fall and during the winter (Van Tighem 2001). Snow depth and restricted availability of good quality forage mean that deer often congregate in groups in suitable winter range. When not constrained by winter snow, white-tailed deer prefer groups of no more than 10 individuals (Van Tighem 2001). During the spring and summer, mule and white-tailed deer bucks form small bachelor herds or become solitary, whereas does often associate with other does and their fawns following fawning (Van Tighem 2001, Lingle 2003).

1.3 Habitat Requirements

1.3.1 General

A combination of cover and feeding areas is critical for both mule and white-tailed deer (AEP 1995). A shrub, forest, meadow complex is ideal for deer in that it provides a combination of good forage selection and cover to provide protection from the elements and from predators (AEP 1995). Due to the limited availability of cover and water on the prairies, shrubby and hardwood draws and wooded river valleys provide important thermal cover, succulent vegetation, open water, travel corridors and diverse forage for deer (Nietfeld *et al.* 1985). Riparian and wetland zones are therefore heavily used by deer (Nietfeld *et al.* 1985).

1.3.2 Fawning Sites

In order to escape predation in early life, fawns rely on hiding cover and are considered hider-type neonates (Kie *et al.* 1991). Young deer are spotted and scentless and will hide under shrubs or trees or in tall grass for a month to nurse (Gadd 1995). A doe will cache their fawns separately often under the lower boughs of spruce trees or in brush up to 100 m apart (Gadd 1995). Dense shrub cover and proximity to forest cover and water, such as riparian areas, are considered optimal fawning habitat (Wood *et al.* 1999). Woody draws, drainages, and basins with slopes of less than 15% are commonly used for fawning cover by white-tailed deer in Alberta (Nietfeld *et al.* 1985). In the grasslands, mule deer use deciduous thickets for fawning sites (Nietfeld *et al.* 1985). Availability of water within 180 m is considered important during fawning (Nietfeld *et al.* 1985).

1.3.3 Summer Habitat

Deer are more versatile in their habitat use during the summer than during the winter as they are not limited by snow cover and can choose from a more varied, higher quality forage supply. Consequently, deer are typically more dispersed and occur in lower densities across the prairie landscape during the summer (Van Tighem 2001). Proximity to water may limit the extent of deer summer range during drought years (Nietfeld *et al.* 1985). The summer is a critical growth period for deer to restore energy reserves depleted over the winter months (Loft *et al.* 1991). The quality of summer habitat is important to ensure proper nourishment of deer in preparation for the winter (Scotter 1980). Early-season summer habitat is particularly important to maternal female deer that have a high nutritional demand and rely on high quality forage and cover to nourish and hide young fawns (Loft *et al* 1991).

In general, white-tailed deer tend to stay close to riparian areas year-round in prairie environments, as they are more adapted to dense cover (Van Tighem 2001). Mule deer typically use more open habitats, but do require some cover for daytime bedding (Nietfeld *et al.* 1985). Shelterbelts in an agricultural field, or sagebrush or shrubby draws in open prairie, provide adequate bedding cover in open areas (Taggart pers. comm.). Mule deer have been observed to use the same bedding areas over a summer perhaps as a predator-defense behavior (Collins and Urness 1983).

1.3.4 Winter Habitat

Snow depth is the critical factor that forces deer to migrate to suitable wintering ranges and determines the extent of suitable range available to deer (Scotter 1980). Generally, a snow depth of approximately 46 cm for mule deer, and snow depths of approximately 41 cm to 50 cm for white-tailed deer, prompt them to leave their favorite summer or early fall range and head towards winter ranges (Kramer 1971a). Deer in the Milk River Basin reportedly move to winter ranges when snow depths reach 15 cm to 20 cm (Taggart pers. comm.). Winter ranges used by deer in southern Alberta tend to be south and west facing, wind swept grassy slopes that have the least snow cover (Taggart pers. comm.). Areas with less snow improve access to forage and ease of movement.

In the Milk River Basin, white-tailed deer are found in treed river valleys in the winter, whereas mule deer are more likely to use coulee breaks and slopes (Lingle pers. comm., Taggart pers. comm.). In addition to treed river valleys, coniferous shelter-belts and aspen clumps also provide winter thermal cover for both species of deer (AEP 1995, Teer 1996). There may be a greater need for sufficient winter cover for white-tailed deer in southern Alberta as there is a higher winter mortality rate for this species (Taggart pers. comm.). The preference of white-tailed deer for habitats with a greater degree of woody cover such as forests, shrublands and riparian forests is well documented (Teer 1996). A 60 to 40 ratio of forage to cover is considered optimal for winter mule deer habitat (Wood *et al.* 1999).

1.3.5 Area Requirements

Deer home range size depends on availability of food and cover and typically varies according to season (Nietfeld *et al.* 1985). Where adequate food and cover is available home ranges tend to be small (Nietfeld *et al.* 1985).

White-tailed deer summer home ranges vary from 70 ha to 190 ha while winter home ranges vary from 160 ha to 480 ha (Nietfeld *et al.* 1985). In areas of good habitat, white-tailed deer may remain in a 500 ha to 800 ha area (Nietfeld *et al.* 1985). For white-tailed deer in Alberta, the following optimum sizes of various cover types have been reported: thermal cover – 0.8 ha to 2.0 ha; hiding cover – 2.6 ha to 10.5 ha; and fawning cover – 0.4 ha to 2.0 ha (Nietfeld *et al.* 1985). Similar optimum sizes of thermal cover (0.8 ha to 2.0 ha) have been reported for mule deer (Nietfeld *et al.* 1985). In the Sierra Nevada, California, female mule deer summer ranges averaged 88 ha in the absence of cattle grazing, and ranged from 103 ha to 124 ha with heavy grazing (Kie *et al.* 1991). Deer densities vary considerably across the landscape of the Milk River Basin. High densities of mule deer occur in association with areas of shrubland and high topographic relief, such as coulees, sandstone complexes and badlands (Quinlan pers. comm.). The highest densities of white-tailed deer exist in the riparian habitats of major drainages, often in association with cottonwood stands, and in agricultural areas (Quinlan pers. comm.).

1.4 Mule and White-Tailed Deer Interactions

As there is a high degree of dietary overlap between mule and white tailed-deer, the potential for competition between these species does exist (Rhude and Hall 1977). Topographical segregation and differing antipredator behaviour between mule and white-tailed deer may lessen opportunities for competition to occur (Swenson *et al.* 1983, Wood *et al.* 1989, Lingle pers. comm.). As mentioned previously, mule deer tend to prefer more rugged and open terrain, while white-tailed deer prefer gentler terrain with greater cover (Lingle pers. comm.). In general, potential for competition is increased where forage is limiting such as during drought conditions or in areas that are intensively grazed by cattle (Peek and Krausman 1996). There is also potential for habitat overlap between these species in prairie areas where cover is limiting or during winters with high snow cover. However, overall, Kramer (1971b) suggested that competition between white-tailed and mule deer is not significant in natural habitat. Similarly, Lingle (2002) reported similar feeding habits by mule and white-tailed deer with no evidence of competition in southeastern Alberta.

1.5 Mule and White-Tailed Deer Response to Livestock Grazing

Domestic livestock grazing has the potential to affect the quality of deer habitat by changing plant productivity or altering plant succession in a manner that either favours or reduces forage and cover (Peek and Krausman 1996). Deer may also be influenced by the presence of livestock on the landscape and associated human activity (Peek and Krausman 1996). The relationship between deer and livestock varies locally and depends on ecological conditions (*i.e.* plant communities and productivity, topography and climate) (Peek and Krausman 1996). In general, there is low dietary overlap between deer and cattle; however the degree of overlap varies with intensity of use of a range and is affected by drought conditions (Peek and Krausman 1996). Grasses typically dominate the summer diet of cattle, while deer consume a significantly greater proportion of browse and forbs (Loft *et al.* 1991, Peek and Krausman 1996). As cattle have proportionately larger rumens than deer, they are able to digest forage of lower quality (Peek and Krausman 1996). Potential for competition between deer and cattle is increased with higher cattle stocking rates and during years of below average precipitation (Kie *et al.* 1991, Peek and Krausman 1996). Under these conditions the ability to partition resources is limited and competition is thereby intensified (Stewart *et al.* 2002). Potential for competition is also increased in arid environments due to limited cover and availability of water, and subsequently a shared preference for riparian zones (Holechek *et al.* 1982).

Various studies have demonstrated that livestock grazing can exert an influence on deer activity or distribution patterns, habitat use and population density (Kie *et al.* 1991, Loft *et al.* 1991, Telfer 1994, Peek and Krausman 1996). Kie *et al.* (1991) and Loft *et al.* (1991) studied the influence of grazing on female mule deer on summer range in Sierra Nevada, California. Cattle grazing reduced the availability of forbs preferred by mule deer especially in late summer (Kie *et al.* 1991). To compensate, deer consumed a broader range of plants with lesser nutritive value such as sedges (Kie *et al.* 1991). In addition, deer reportedly spent more time feeding and less time resting and increased their home ranges to include steeper slopes and less preferred habitat (Kie *et al.* 1991, Loft *et al.* 1991). Moderate to heavy livestock grazing reduced deer use of preferred meadow-riparian areas and excluded their use of aspen habitats due to reduced forage and cover abundance (Loft *et al.* 1991). The greatest potential for diet overlap and competition with cattle and mule deer occurred in late summer in mutually preferred meadow-riparian habitats when forage was at a minimum (Loft *et al.* 1991). Therefore, moderate to heavy livestock grazing can result in competition for forage and increase predation risks to deer by reducing hiding cover available to fawns and forcing deer to spend more time feeding (Kie *et al.* 1991, Loft *et al.* 1991). As deer are displaced from preferred habitats by heavy cattle grazing this may also influence their nutrition, survival, and productivity.

Telfer (1994) examined cattle and cervid (moose, elk and deer) interactions on a foothills watershed in southwestern Alberta. Cattle diets were most similar to elk diets, being comprised primarily of herbaceous material (grasses and forbs). Cattle diets consisted of 89% herbaceous material. Deer diets contained minor amounts (6.4%) of herbaceous matter and 43% browse (primarily from Saskatoon shrubs and aspen). Deer selected the forest cover and browse of steep middle slopes, while cattle primarily used lower slopes (less than 20%) with high herbaceous cover. The tendency for cattle to prefer lower elevations and avoid steep slopes further from water is widely reported (Berg and Hudson 1981, Peek and Krausman 1996, Stewart *et al.* 2002). Telfer (1994) did not find definite evidence of competition between cattle and cervids, however, there was extensive overlap in use of space, habitat, and forage resources overall. In a similar study, Berg and Hudson (1981), found high overlaps for temporal, topographical and habitat variables, and low dietary and spatial overlaps between mule deer and cattle. In the northwestern United States, Stewart *et al.* (2002) found strong resource partitioning between, elk, mule deer and cattle and evidence that competition resulted in spatial displacement. Unlike cattle, elk and mule deer used similar, steeper slopes and higher elevations. There was high spatial and dietary overlap between mule deer and elk in autumn, but partitioned use of vegetation communities occurred during the summer. Deer and elk shifted use to lower elevations and more level slopes when cattle were absent. Willms *et al.* (1979) found that the potential for direct competition between mule deer and cattle on big sagebrush range in British Columbia was greatest in spring. Both mule deer and cattle selected bluebunch wheatgrass and crested wheatgrass.

Despite the potential for competition between deer and cattle, under appropriate management, livestock grazing can benefit deer and maintain the condition of the range (Holechek *et al.* 1982, Peek and Krausman 1996, Teer 1996). Well-managed livestock grazing can stimulate the diversity and abundance of grass, forb and browse species that provide a variety of forage for deer throughout the seasons (Bryant *et al.* 1981). Removal of unpalatable standing dead material by fall cattle grazing, for example, benefits spring grazing opportunities for deer and elk (Short and Knight 2003). Short and Knight (2003) found that fall grazing in rough fescue range in Montana increased green growth available to deer in the spring and did not compromise fescue forage production. Deer and elk select green grass growth during the spring for its high nutritive value and increased palatability (Short and Knight 2003). The benefits of fall grazing have also been demonstrated in bluebunch wheatgrass - big sagebrush range in British Columbia (Willms *et al.* 1979, 1980, 1981). Willms *et al.* (1979) noted that moderate or heavy fall grazing by cattle made the spring forage more attractive to deer, while light grazing did not have an appreciable effect on deer distribution. Fall grazing benefits have not been shown for dry mixedgrass or mixedgrass prairie, where rank litter build-up is generally not a concern due to more arid conditions and less productivity. Fall grazing benefits also may not apply to valuable deer winter range due to potential competition for limited winter forage and spatial displacement of deer during critical winter periods (Short and Knight 2003).

In the absence of cattle grazing, deer foraging habitat can be reduced due to shifts in succession from communities formerly dominated by xeric shrubs such as big sagebrush toward a perennial grass-forb community (Austin and Urness 1998). A combination of deer and cattle grazing imposes a balance of use on all forage components and thereby prevents shifts in competitive advantage (Severson and Urness 1994). Because bison and cattle are both generalist herbivores that graze preferentially on graminoids, a similar relationship likely existed historically between bison and deer (Knapp *et al.* 1999). However, direct comparisons between bison and cattle are inappropriate given that cattle are considered more sedentary than bison and use a significantly lower percentage of upland habitat compared with bison, preferring gentler terrain and floodplain habitat (Knapp *et al.* 1999). Despite inherent differences in their grazing behaviour, cattle, as large grass-feeding herbivores, may be able to fulfill a similar ecological function as bison under appropriate management. Grazing management strategies including stocking rates, duration and timing as well as distribution tactics can be used to achieve a greater degree of ecological equivalency between bison and cattle (Knapp *et al.* 1999).

1.6 Grazing Systems and Deer Habitat Management

Several studies have examined the effects of various grazing systems on the habitat needs and reproductive success of the mule and white-tailed deer (Reardon *et al.* 1978, Bryant *et al.* 1981, Holechek *et al.* 1982, Kie *et al.* 1991, Peek and Krausman 1996). Stocking rate and the timing and distribution of cattle are decisive factors influencing the potential benefits or detriments of each grazing system (Table III-10). Most studies indicate that deer do poorly on ranges stocked heavily with livestock that are grazed continuously year after year (Bryant *et al.* 1981). There tends to be a more positive response for deer if there is periodic resting of the range from domestic livestock (Bryant *et al.* 1981). Deer are reported to make greater use of deferred-rotation pastures, the more frequent the deferment the higher the preference (Reardon *et al.* 1978, Holechek *et al.* 1982). A grazing system that encourages removal of mature grass followed by periodic rest makes nutritious regrowth available to deer during the rest period (Bryant *et al.* 1981).

The potential positive and negative implications of five grazing systems (continuous, complementary, rotational, intensive, and riparian area grazing) on deer habitat are discussed further in Table III-10.

Table III-10 Grazing Systems and Deer Habitat Management

Grazing System	Discussion
Continuous (Season-Long) Grazing	
Advantages:	Provided proper utilization rates are observed, continuously grazed pastures can be managed in a manner that provides sustainable forage for both deer and cattle. Stocking rates should take into consideration the combined removal of forage biomass by cattle and deer (Telfer 1994). Light or moderate stocking rates and conservative utilization rates (40% to 50%) ensure more sustainable rangeland productivity for cattle and wild ungulates (Holechek *et al*. 1982, Kie *et al.* 1991, Peek and Krausman 1996, Teer 1996). To counter some of the potential negative impacts of continuous grazing, strategies such as salt and water placement can be used to encourage cattle away from critical deer habitat (such as riparian areas or critical winter range).
Disadvantages:	Deer have been noted to do poorly on heavily stocked ranges that are continuously grazed year after year (Bryant *et al.* 1981, Holechek *et al.* 1982, Peek and Krausman 1996). Continuous grazing at high stocking rates reduces available forage and cover for deer and fawns resulting in potential displacement or altered activity patterns of deer, heightened predation risks, and reduced productivity and survival (Kie *et al.* 1991). Availability of adequate forage during the summer is particularly crucial to adult females to enable them to meet the energetic demands of lactation (Kie *et al.*1991). Under continuous grazing, forage availability is typically reduced to a minimum by the end of the season, particularly during drought years. Over a period of years this type of grazing results in deterioration of range condition. Bryant *et al.* (1981) found that diet samples from poor condition rangeland near Sonora, Texas had significantly lower yearly averages of crude protein and phosphorus than samples from higher condition pasture. Reduced forage quantity and quality may result in displacement of deer from native prairie and increased deer depredation of surrounding agricultural cropland (Swenson *et al.* 1983, Loft *et al.* 1991). Under continuous grazing, the greatest negative impacts from cattle grazing are often associated with unrestricted use of riparian areas. Riparian areas are particularly important to deer in arid prairies for providing diverse forage and shelter (Nietfeld *et al.*1985). Heavy cattle use in riparian areas diminishes both woody and herbaceous cover through repeated utilization and trampling (Fitch and Adams 1998).
Complementary Grazing	
Advantages:	Complementary grazing, a form of deferred grazing, offers several potential advantages to deer. Complementary grazing allows deferred use of native rangeland and an extended grazing season by utilizing seeded pasture in the spring. Early season deferment of native prairie provides increased security of hiding cover for fawns and is also beneficial to improving the health of riparian areas (Fitch and Adams 1998). This system can also improve the yield and condition of native prairie. Tame forage species such as meadow brome (*Bromus biebersteinii*) and Russian wild rye grass (*Elymus junceus)* initiate growth early in the season and therefore are more palatable and nutritious to both deer and cattle from late April to mid-June than are common perennial native grasses. Russian wild-rye also has a long growth season and a high protein content, is drought and cold tolerant, and is palatable in the fall (Looman 1983). Availability of high quality forage is particularly important to deer early in the season to replenish energy reserves that are depleted through the winter (Wallmo *et al.* 1977). Grass use by deer is highest in the spring (Peek and Krausman 1996). Deer favour green grasses with higher nutritive value that initiate growth early (Peek and Krausman 1996). Seeded pastures, strategically placed, can therefore function as lure forage to attract deer away from crop fields.

Grazing System	Discussion
Complementary Grazing Cont'd.	
Disadvantages:	The cumulative benefits of complementary grazing depend on whether seeded pastures compromise formerly productive deer habitat (i.e. shrubland, wetland edge habitat or important sheltering and winter habitat). If complementary grazing systems are created by seeding marginal cropland to permanent cover, the benefits of this system in terms of deer habitat are greatly increased. As deer are attracted to seeded pastures in the spring, this creates the potential for competition with cattle on these pastures, particularly if there is a shortage of alternate high quality forage. Heavy use of seeded pastures reduces their productivity and vigour, and means that re-seeding may be required on a more frequent basis. Hall and Stout (1999) report that deer feeding reduced annual yield of pure alfalfa pastures by an average of 54%. Hall and Stout (1999) recommend alfalfa – grass mixtures as opposed to pure alfalfa to reduce economic losses due to deer feeding. It is possible that damage to seeded pasture and cropland will be lessened if deferred grazing allows for improved native range condition. Native range typically offers a greater diversity of forage and cover types than seeded pasture and therefore may be preferable to deer.
Rotational Grazing	
Advantages:	Rotational grazing systems with suitable stocking rates are generally considered to be most beneficial to deer (Reardon *et al.* 1978, Holechek *et al.* 1982, Kie *et al.* 1991, Peek and Krausman 1996, Teer 1996). Grazing systems that allow for periodic rest of the range are advantageous to deer as livestock remove mature grass herbage and stimulate nutritious regrowth that is available to deer during the rest period (Bryant *et al.* 1981). Periodic rest and rotational use also allows for improved carryover and reduces selective grazing by cattle, forcing overall better utilization of the range. Rotational grazing also offers a strategy to control cattle use of riparian areas, allowing for rest or recovery of riparian areas and improved vigour of important browse, shrubs and grasses used by deer. Rest-rotation systems that allow for a year of non-use can better facilitate recovery and maintenance of important browse species such as willows and preferred shrubs (Fitch and Adams 1998). Bryant *et al.* (1981) reported that a Merrill, 4-pasture grazing system increased the availability and use by deer of grass regrowth; supported higher densities of deer than continuous year-long grazing systems; and maintained the range in excellent condition. A Merrill grazing system is a deferred, rotational grazing strategy using multiple herds. This system grazes 3 herds of livestock in 4 grazing units with one unit deferred at all times (Reardon *et al.* 1978, Holechek *et al.* 1982). Kie *et al.* (1991) stressed the importance of deferring grazing early in the season on native range to protect suitable hiding cover for deer fawns and to ensure sufficient forage for lactating females. Kie *et al.* (1991) recommend a deferred rotation grazing system with half of the allotment grazed in early summer and the other half in late summer at moderate levels, with the order of grazing rotated each year. Reardon *et al.* (1978) noted that deer preferred Merill grazing systems, the more frequent the deferment the higher the preference. Loomis *et al.* (1991) evaluated the effect of 3 grazing systems on summer range in Sierra Nevada, California, on deer carrying capacities. A rest-rotation system involving 1 or 2 years of rest (nonuse) of each pasture increased the potential carrying capacity of the range for mule deer in comparison to continuous moderate grazing and short-duration grazing (Loomis *et al.* 1991, Peek and Krausman 1996).
Disadvantages:	Rotational grazing systems typically require higher input costs due to the need for more fencing or water developments and additional range-riding. These costs can be balanced by improved condition of native range and potential to increase cattle stocking rates, as well as potential for higher sustainable deer carrying capacities. Monitoring range condition and adjustment of stocking rates is important to ensure moderate use. As grazing is less selective under rotational grazing systems, under heavy stocking rates, cattle will more heavily utilize important deer forage.

Grazing System	Discussion
Intensive Grazing	
Advantages:	Intensive grazing systems with sufficient rest and frequent monitoring may be suitable for stimulating a diversity of forb and browse forage for deer by maintaining range in lower seral stages. Reardon *et al.* (1978) found that white-tailed deer density was highest in a 7 pasture short duration grazing system in which pastures were grazed for 6 to 9 weeks then rested for the remainder of the year. However, as this study was conducted in Sonora, Texas, its applicability to southern Alberta is questionable. Few studies have shown demonstrable positive affects of intensive grazing systems for deer in southern Alberta.
Disadvantages:	High intensity, low frequency (short duration) grazing systems have been noted to have the greatest potential to damage important deer browse, forbs and seed producing species as well as cover (Teer 1996). Deer have been observed to avoid areas occupied by large numbers of cattle and shift use to other areas of their home range (Peek and Krausman 1996). This can result in deer being excluded from preferred habitat and pushed into less productive habitat with reduced cover and can lead to forage competition between deer and cattle (Kie *et al.* 1991, Loft *et al.* 1991). The implications of this to deer survival depend on the timing of grazing. Heavy use of preferred deer habitats in the spring or fall can be particularly damaging as deer have increased energy demands prior to and following winter (Kie *et al.* 1991). Heavy use in the spring can also be particularly harmful to depleting available hiding cover for new born fawns and for causing significant damage to riparian areas at a time when banks are soft and vulnerable to trampling impact. Under short-duration, high intensity grazing systems, cattle are less selective and will utilize all available forage, including important deer cover or forage that would not be grazed under lower stocking rates. Intensive grazing systems can also lead to increased erosion and increased soil bulk density in mixedgrass prairie and result in loss of desirable forage species on fescue prairie (Dormaar *et al.* 1989, Willms *et al.* 1993).
Riparian Area Grazing	
Advantages:	River and creek valleys and wetland edge riparian habitat provides critical year-round deer habitat in the prairies of southern Alberta (Nietfeld *et al.* 1985). The trees, shrubs and tall herbaceous vegetation found in these habitats provide valuable shelter and security cover as well as diverse forage for deer (Nietfeld *et al.* 1985). Without appropriate management systems, cattle will linger in riparian areas and through excessive trampling and repeated use, can diminish the availability of forage and cover for deer and fawns, and cause sedimentation of the water body (Fitch and Adams 1998). Various riparian area grazing systems are available such as rest or deferred rotational grazing or corridor fencing that aim to control the timing and intensity of cattle use in riparian areas to minimize damage and facilitate rest and recovery. These types of strategies have proven to improve the health of riparian ecosystems and concurrently enhance their value as important deer habitat (Fitch and Adams 1998). Improved regeneration and long-term sustainability of woody browse, increased availability and productivity of herbaceous cover, as well as potential for improved water quality are obvious benefits to deer from implementing appropriate riparian area grazing strategies.
Disadvantages:	Even with controlled use of riparian areas by cattle, intensive deer utilization can limit regeneration and recovery of woody riparian species (Opperman and Merenlender 2000). Deer fencing or shrub or tree planting may be required in these instances to ensure long-term sustainability of certain riparian reaches. Controlling cattle use in riparian areas is also associated with economic costs due to fencing and alternate water source developments.

1.7 Range Improvements and Deer Habitat Enhancement

Aside from using cattle grazing as a habitat management tool, there are other types of range improvements that can enhance habitat for deer. Prescribed burning, for example, has been shown to increase the long-term availability, palatability and nutritive quality of forage for deer by stimulating primary productivity in subsequent years (Scotter 1980, Pearson *et al.* 1995). Pearson *et al.* (1995) monitored winter habitat use by large ungulates following a fire in Northern Yellowstone National Park. Burned areas were used by ungulates more often than expected particularly during mid to late winter, and resulted in greater forage procurement for ungulates 3 to 4 years post-fire (Pearson *et al.* 1995). Similarly, the nutritional quality of mule deer winter diets was enhanced significantly after a fire in the Front Range of Colorado due to higher levels of crude protein in diets from burned sites (Hobbs and Spowart 1984). Mule deer obtained more green grass from burned areas (Hobbs and Spowart 1984). Fire also improved forage availability by removing dead woody tissue or litter (Hobbs and Spowart 1984, Pearson *et al.* 1995). Deer make little use of mature grass or sedges in their diet, and benefit when grass regrowth or forbs are made accessible (Collins and Urness 1983). Willms *et al.* (1980, 1981) reported that deer selected burned plants in greater proportion than grazed plants in the spring following fall burning and grazing treatments in bluebunch wheatgrass range in British Columbia. Fire is also beneficial not only in terms of improving forage quality but also for maintaining edge habitat and preferred shrub meadow habitats (Cairns and Telfer 1980).

Other range improvements such as seeding may also improve deer habitat, while practices such as brush removal can negatively affect deer. Seeding marginal cropland to a permanent cover of forages such as Russian wildrye provides nutritious forage for deer and cattle in the early spring and late fall as part of a complementary grazing strategy (Table III-10) (Urness 1981). These grass species initiate earlier growth in the spring and produce larger amounts of fall regrowth than most native perennial grasses (Urness 1981). Brush removal negatively impacts deer by reducing cover and forage. If brush management is considered necessary to increase grass forage production for cattle, leaving brush patches is important to provide residual habitat for deer (Reardon *et al.* 1978). Teer (1996) suggests that brush is cleared in a checkerboard or strip pattern whereby 40% of the brush is left and 60% is cleared. No clearing of brush should occur in key winter ranges such as south facing slopes (Teer 1996). Connections between brush tracts should be left intact as travel corridors (Teer 1996).

1.8 Beneficial Management Practice Recommendations

Ideal deer habitat is comprised of a diversity of plant species, a mosaic of vegetation types and an availability of varying degrees and types of cover (Teer 1996). Management of deer habitat involves managing the quality and quantity of forage as well as the types and amount of cover available to deer (Scotter 1980). It is especially important that land use and grazing management focus on maintaining or enhancing the condition of key habitats such as wintering range, fawning sites, and riparian zones (Teer 1996). The following recommendations provide a variety of means by which to enhance deer habitat in the Milk River Basin and throughout the Grassland Natural Region of Alberta.

1.8.1 General Recommendations

- Maintain landscapes with a diversity of cover types including intact riparian habitat, shrublands, aspen or poplar groves, shelterbelts, native prairie, seeded pasture and some cropland. Habitats with greater diversity can sustain stable deer populations by increasing forage and cover opportunities throughout the year (Teer 1996).
- Maintain shelterbelts in cultivated areas to provide cover and bedding areas for deer and supplemental browse. Isolated shelterbelts or woody cover in open prairie is particularly important to mule deer (Nietfeld 1985).
- Enhance, maintain, and control sustainable use of riparian edge habitat around creeks, rivers and wetlands. Woody species (trees and shrubs), and productive herbaceous vegetation associated with riparian habitats provide excellent deer forage and cover. Riparian corridors are also important as secure travel corridors for deer (Scotter 1980). Maintaining connected areas of dense cover is especially important for white-tailed deer (Nietfeld *et al.* 1985).
- Protect critical winter range habitat (south and west facing exposed slopes) from cultivation or development. Monitor the condition of winter range forage on a regular basis (Scotter 1980).
- Avoid human disturbance in critical winter ranges especially during severe winters with cold temperatures and snow depths exceeding 15 cm to 20 cm (Taggart pers. comm.).
- Maintain patches of 0.4 ha to 2.0 ha of thermal vegetation and fawning cover (trees or shrubs and tall herbaceous cover) (Nietfeld *et al.* 1985).
- Maintain patches of 2.6 ha to 10.5 ha of hiding cover for deer during all seasons (Nietfeld *et al.* 1985). Maintain connectivity between patches of hiding cover, where possible (Scotter 1980).
- Maintain preferred browse species including chokecherry, rose, snowberry, silverberry, juniper, red-osier dogwood and aspen (Nietfeld *et al.* 1985).
- Seeded pastures and cropland are used for foraging by deer particularly during early spring and fall. Alfalfa-grass mixtures may result in less yield loss due to deer feeding than pure alfalfa (Hall and Stout 1999). Where seeded pastures are used as lure crops for deer to prevent impact to cropland, consider strategic placement of pastures near to adequate cover and use a forage mix with high nutritional value early and late in the season.
- Avoid converting large areas of native prairie to monoculture cropland. Cultivation creates habitat fragmentation, reduces habitat diversity and eliminates important native forage and cover (Nietfeld *et al.* 1985).
- Prescribed burning may be an appropriate tool to enhance habitat for deer in areas with thick build-up of standing dead litter, such as underutilized rough fescue grasslands (Pearson *et al.* 1995). It is important to create a patchwork of burned and non-burned areas to provide habitat diversity and ensure sufficient forage and cover for deer in the short-term (Bryant and Morrison 1985). Leaving some areas permanently protected from burning is also important. The size and distribution of burns should be determined in consultation with local ecological experts. Burns should only be conducted in years with sufficient moisture. Bryant and Morrison (1985) recommend deferring cattle grazing in fall burned pastures between April to

July. To allow sufficient rest between burns, frequency of burns should be determined according to the natural historic fire regime for the area.

1.8.2 Grazing Recommendations

Grazing can be used as a tool to enhance deer habitat by increasing plant species diversity, reducing build-up of thick standing dead litter and encouraging growth of early season forbs and grasses (Peek and Krausman 1996). Grazing systems that will benefit deer need to maintain suitable stocking rates that allow for maintained grassland productivity and consider the combined removal of forage biomass by livestock and deer. In general, competition between domestic livestock and deer is most severe on degraded ranges that are heavily stocked (Teer 1996). Controlling the timing, intensity and frequency of grazing impacts the degree of potential competition between cattle and deer. Grazing management decisions need to be tailored to meet local ecological conditions, taking into consideration how changes in management will impact important deer forage and cover through the seasons. Adequate winter range forage, availability of early season grasses, and adequate hiding cover for fawns are especially important considerations. Appropriate grazing systems for deer should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

The following list summarizes key livestock grazing management principles where the goal is to enhance deer habitat:

- Use livestock grazing in combination with deer herbivory to maintain a balanced grass / forb / browse ratio (Scotter 1980).
- Promote applicable proper use factors for fescue (40%) and mixedgrass prairie (50%) to ensure a sufficient degree of carry-over remains and rangeland productivity is sustained (Adams *et al.* 1994).
- Monitor utilization rates of woody browse and determine the use-tolerance of preferred deer browse species that does not result in lost vigour or productivity (Scotter 1980). Manage for sustainable cattle and deer browse use through the use of fencing, rest and light to moderate stocking rates.
- Track annual grazing capacities; vary stocking rates and distribution in accordance with drought events and range condition. Consider contribution of deer herbivory when setting stocking rates.
- Avoid intensive grazing systems with high density stocking rates over large areas.
- Use complementary grazing as a means to defer early-season use of native prairie and provide supplemental seeded forage for deer in the spring and fall.
- Implement rotational grazing systems to provide parts of the range with deferred early season grazing and controlled periods of rest (Reardon *et al.* 1978, Holechek *et al.* 1982, Kie *et al.* 1991, Peek and Krausman 1996, Teer 1996). Deferred use and rest benefits the availability and quality of deer forage and improves security of hiding, thermal, and fawning cover. Rotational grazing systems also provide a tool to manage cattle use of critical riparian area

habitat (Fitch and Adams 1998). One season of rest is sufficient to improve herbaceous cover, while a longer period of rest may be required to improve woody species cover (Scotter 1980).

- Where appropriate, use fall grazing to improve spring grass-forb forage availability and quality for deer in fescue prairie (Peek and Krausman 1996, Short and Knight 2003). Livestock grazing can be used to improve vegetation conditions for deer by removing old growth and stimulating the production of new growth to provide palatable deer forage in the spring (Peek and Krausman 1996).
- Avoid over-utilization on critical winter ranges including south and west facing slopes along valleys or coulees and treed or densely vegetated riparian corridors. Avoiding late-season use of these areas is important to ensure sufficient forage remains for deer during the winter months (Short and Knight 2003). Where necessary, fencing can be used to restrict cattle access to key winter-range habitat.
- Manage and monitor cattle use of upland woody vegetation to ensure trees and shrubs are healthy and capable of regenerating. Avoid placing salt near to aspen or shrubby draws.
- Manage grazing in creek, river or wetland riparian areas to enhance habitat value (forage and cover) for deer (Collins and Urness 1983).
- The optimal time of use of riparian areas is during the summer after spring runoff when the stream banks are no longer soft, and before the dormant season (Fitch and Adams 1998).
- Distribute salt away from riparian habitats to reduce impact to these areas and encourage better utilization of the range.
- Develop upland stockwater, where necessary, to control heavy use of riparian areas. Stockwater provides alternate watering sites for cattle as well as deer. Availability of alternate watering sites improves deer distribution in dry years, in particular (Scotter 1980). Nietfeld *et al.* (1985) stated that optimum mule deer habitat has open water within 0.8 km of any point. Only water sources in proximity to sufficient cover are likely to be used by white-tailed deer (Nietfeld *et al.* 1985).
- Deferred-rotation, rest-rotation, riparian pasture and corridor fencing have been suggested as techniques for improving the health of riparian areas (Fitch and Adams 1998). Several years of rest may be required where the goal is to regenerate trees like cottonwoods (Fitch and Adams 1998).
- Consider the relative impact of deer on utilization of riparian woody browse. Evaluate strategies such as tree or shrub planting or upland habitat enhancement techniques where heavy use is occurring. Maintaining deer at sustainable population levels through the use of managed hunting is also important to ensure sustainable use of critical riparian habitats.

1.9 Research Recommendations

To refine specific cattle grazing recommendations for mule and white-tailed deer in the Milk River Basin, additional local information regarding deer habitat requirements, deer-cattle interactions, and deer effects on agricultural resources is required. Additional information regarding various deer range improvement techniques (such as prescribed burning) would also be valuable.

Habitat suitability modeling would provide a valuable tool for defining and mapping out the amounts and kinds of habitats frequently used by deer within the Milk River Basin and rating the importance of each habitat type. Development of habitat suitability index models (HSI models) for deer should be based on existing habitat use and population survey information. Traditional ecological knowledge acquired through landowner and hunter consultation can be valuable in confirming local deer use patterns. Where necessary, habitat selection studies could be used to confirm or analyze deer use patterns throughout the year. Final models should aim to map out the following features within the Milk River Basin:

- key winter ranges;
- critical thermal, hiding, escape or fawning cover; and
- prime spring and summer ranges.

Research concerning the interaction between livestock and deer should consider an evaluation of the following factors:

- the relative use by deer of habitats with varying intensities or frequencies of cattle grazing;
- the potential for cattle and deer competition or resource partitioning at different times of the year;
- the relative importance of forage versus structural features to deer and how each is affected by cattle grazing;
- the effects of cattle grazing on the quality and sustainability of critical deer winter range habitat;
- application of fall grazing to enhance deer spring forage;
- relative cattle and deer utilization of critical riparian habitats; and
- a comparative evaluation of various grazing strategies to enhance deer habitat and minimize impact to agricultural resources.

Planned studies with experimental manipulation of livestock to control timing and intensity of grazing will be beneficial in evaluating the response of deer to various cattle grazing strategies (Teer 1996, Stewart *et al.* 2002). As deer use patterns are affected by cattle grazing, assessing preferential deer habitats requires manipulation of grazing levels as well as studying control areas that are ungrazed by cattle (Stewart *et al.* 2002). As human use patterns also have an obvious impact on deer behavioural patterns, studies should also evaluate habitat use relative to varying degrees of human activity (Scotter 1980).

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III: REPTILES AND AMPHIBIANS

A. REPTILE GROUP (PRAIRIE RATTLESNAKE, BULLSNAKE AND SHORT-HORNED LIZARD

1 INTRODUCTION

The purpose of this report is to summarize and compare the ecological and habitat requirements of three reptile species found within the Milk River Basin: the prairie rattlesnake (*Crotalus viridis viridis*), bullsnake (*Pituophis catenifer sayi*), and short-horned lizard (*Phrynosoma hernandesi hernandesi*). Based on this information, the potential effects of grazing and various grazing systems on these reptiles, their habitat requirements and their prey are discussed. This discussion is followed by a summary of recommended beneficial management practices to enhance or protect reptile populations and their habitat in the Milk River Basin and throughout their range in southeastern Alberta. Lastly, a brief summary of additional information needs is presented.

Prairie rattlesnakes, bullsnakes and short-horned lizards are at or near the northern edges of their North American ranges in Alberta, and are very locally distributed in southeastern Alberta. The majority of the breeding range of the short-horned lizard in Alberta is encompassed by the Milk River Basin. To enable them to survive the harsh winters of a northern climate, these reptiles hibernate in overwintering sites or hibernacula. Other key habitat components include birthing areas, also known as rookeries (rattlesnakes), nesting sites (bullsnakes), and productive foraging areas. Thermoregulatory properties of the landscape are key determinants in the selection of breeding, wintering and foraging habitat by these reptiles. Due to their limited range or rarity in the Canadian prairies, suspected population declines, and their sensitivity to human disturbances and extreme weather events, their populations are considered either "Sensitive" or "May Be At Risk" in Alberta. Because cattle grazing is the dominant land use within the ranges of these species in the Milk River Basin, understanding the potential impacts of grazing on these species and their habitats is important for their management and long-term conservation. It is also important to consider strategies to minimize potential impacts due to other human activities, such as industrial development, which can pose a risk to these species or their habitats.

2 PRAIRIE RATTLESNAKE

2.1 Background

The prairie rattlesnake is a subspecies of the western rattlesnake (*C. viridis*). The range of this subspecies in North America extends from northern Mexico through the central United States and into southeastern Alberta and Saskatchewan (Watson and Russell 1997).

The prairie rattlesnake is found primarily along major river drainages in southeastern Alberta, with most hibernation sites located along the breaks and coulees of the South Saskatchewan, Red Deer, Bow, Oldman and Milk Rivers (Gannon 1978, Kissner and Nicholson 2003a). The general status of prairie rattlesnakes in Alberta is "May Be At Risk" of extirpation (Alberta Sustainable Resource Development (SRD) 2001a). This species is designated as a "non-game animal" under

Alberta's *Wildlife Act,* making it illegal to kill, possess, buy or sell rattlesnakes. Rattlesnake hibernacula were recently afforded year-round protection from destruction or human disturbance under the *Wildlife Act* (Alberta Endangered Species Conservation Committee (ESCC) 2000). Although significant populations of rattlesnakes persist in some areas of Alberta, anecdotal evidence indicates apparent recent or long-term declines in the distribution and abundance of rattlesnakes across their range in Alberta (Watson and Russell 1997, Kissner and Nicholson 2003bb). However, it has not been possible to accurately analyze rattlesnake population trends or to quantify suspected declines due to a lack of long-term studies on rattlesnakes in Alberta. Lack of accurate population trend data prompted the ESCC to classify the rattlesnake as "Data Deficient" in 2000 (ESCC 2000). As recommended by the ESCC, research is ongoing to develop a standardized, long-term rattlesnake population monitoring program in the province (Nicholson and Rose 2001, Rose 2001).

Declines in rattlesnake abundance and distribution are thought to have resulted from fragmentation and loss of critical native prairie habitats and from direct mortality due to intensive agricultural activities, urbanization, roadway traffic as well as road and pipeline construction (Watson and Russell 1997, Ernst 2002). Intentional persecution and den site vandalism or destruction have also contributed to historic declines of rattlesnakes (Watson and Russell 1997, Ernst 2002). The distribution of prairie rattlesnake populations in Alberta is naturally limited by climatic factors and the availability of suitable hibernacula, summer foraging areas and appropriate birthing areas (Watson and Russell 1997). Rattlesnake populations have slow growth rates and are particularly vulnerable to disturbance because numerous snakes over-winter in the same hibernacula each year.

2.2 Ecology

Prairie rattlesnake distribution patterns, movements and behaviour are strongly influenced by age, sex, and reproductive state (Gannon and Secoy 1984). Prairie rattlesnakes generally emerge from hibernacula in late April or early May and return in mid-September (Duvall *et al.* 1985, Gannon and Secoy 1985, Ernst 2002). Rattlesnakes at more northern latitudes such as in Alberta experience lower body temperatures during hibernation and have a shortened active season than more southerly conspecifics in the United States (Watson and Russell 1997). Early fall frosts and shorter days encourage rattlesnakes to move back to dens. All age-classes and sex classes may occupy the same den (Gannon and Secoy 1984). In the spring, males and nongravid (non-preganant) females migrate into the surrounding prairie to forage and mate, whereas gravid (pregnant) females remain near the denning complex (Gannon and Secoy 1984).

Female rattlesnake reproductive cycles are biennial, triennial, or longer, meaning that individual females produce offspring at most, every two years (Gannon and Secoy 1985). However, female rattlesnakes in Saskatchewan have been found to occasionally give birth annually (Kissner pers. comm.). Most snakes (70%) are oviparous and lay eggs (*e.g.,* bullsnake) with soft leather shells that protect their developing young (Bartlett and Tennant 2000). Rattlesnakes, however, are ovoviviparous, with fertile eggs developing within the females' bodies, and females give birth to living young. Breeding takes place in the summer or early fall and young are born the following year from late August to mid-October (Watson and Russell 1997, Ernst 2002). Breeding often takes place on summer ranges and may also occur at or near hibernation sites

(Kissner pers. comm.). Pregnant females usually give birth near the over wintering den at birthing areas (rookeries) thought to be chosen for their favorable microclimates and possibly to factors that decrease their risk of predation (*e.g.,* cover). Litter sized range from 4 to12 young (Russell and Bauer 2000). Male snakes attain sexual maturity at 3 to 4 years of age, while female snakes mature at 5 to 7 years of age. Given their late reproductive maturity, relatively small litter sizes, and biennial or greater reproductive cycles, rattlesnakes have a slow population growth rate (Watson and Russell 1997).

2.2.1 Diet

Upon emerging from hibernation, snakes move to upland habitats in search of prey, often remaining in areas with high small mammal abundance (Didiuk 1999). Rattlesnakes locate their prey both visually and by using two heat-sensing pits on their upper jaw (Ernst 2002).

Rattlesnakes prey on small mammals, birds, amphibians and other reptiles (Russell and Bauer 2000). The exact composition of the rattlesnake diet varies over its range in relation to the abundance and composition of the local prey base (Hill *et al.* 2001). Hill *et al.* (2001) examined the gut contents of 20 road-killed rattlesnakes and the composition of 8 scats from wild-caught individuals in a multiple land use area in southeastern Alberta. Sagebrush voles (*Lagurus curtatus*) were the dominant prey consumed, constituting 53% and 68%, respectively, of prey items in gut contents and scats. Meadow voles (*Microtus pennsylvanicus*) were the next most frequently consumed prey, constituting 38% of gut contents and 8% of scats. Olive-backed pocket mice (*Peragnathus maniculatus*), western jumping mice (*Zapus princes*) and Richardson's ground squirrels (*Spermophilus richardsonii*) made up a minor portion of the rattlesnake diet. The low occurrence of Richardson's ground squirrels in rattlesnake diets may have been due to their apparent low density within the study area (Hill *et al.* 2001). Rattlesnakes were found to consume multiple prey items of the same species, indicating that snakes tend to exploit patches with an abundance of colonial burrowing prey species (Hill *et al.* 2001). Other studies in Alberta have found that northern pocket gophers (*Thomomys talpoides*) are an important component of rattlesnake diets (Didiuk 1999).

2.2.2 Predators

Common predators of prairie rattlesnakes include badgers, coyotes and various raptor species (Watson and Russell 1997).

2.3 <u>Habitat Requirements</u>

2.3.1 General

In Alberta, the prairie rattlesnake is found within the Mixedgrass and Dry Mixedgrass Subregions of the Grassland Natural Region, most commonly along river valleys and associated coulees, badlands and sage flats (Watson and Russell 1997).

Key habitat components for rattlesnakes include hibernacula (wintering habitat), foraging and thermal cover habitat (summer habitat), and birthing (rookery) sites. Habitat Suitability Index (HSI) models were developed for each of these habitat components for rattlesnakes in the Milk River Basin (Kissner 2004). The wintering habitat HSI model included three, equally weighted variables: distance from escarpment of major river, drainage or coulee; aspect; and a landscape model variable from the Agricultural Region of Alberta Soil Inventory Database (AGRASID). According to this model, sites that are most likely to offer suitable prairie rattlesnake hibernacula occur within 4 km of a major river, coulee or drainage, on south, east, or southeast slopes, and are in areas with rough terrain (high relief, moderate to steep slopes, and greater than 10% exposed bedrock). Hibernation sites are also known to occur in areas of slumping, however, a geographic information system (GIS) coverage was not available for this variable. The summer habitat HSI model was more complex, and included five variables: distance from major river, drainage or coulee; road density; road type; native prairie class; and shrub or tree cover. According to this model, optimal rattlesnake summer habitat occurs within an area of 25 km of a major river, coulee, or drainage, that has low densities of roads (in particular highways and secondary highways) and is characterized by native prairie cover with low to moderate densities of shrubs. Areas with high human densities are also considered unsuitable as summer rattlesnake habitats. The HSI model for identifying potential rookery habitat included four variables: distance from major river, drainage or coulee; aspect; shrub cover; and bare rock cover. According to this model, optimal rookery habitat occurs in areas that are within 1 km to 5 km from a major river, coulee and drainage, and that have south, east, or southeast aspects with moderate shrub cover or bare rock cover. The overall HSI equation included elevation as a determining variable. In general, prairie rattlesnakes do not occur above 1200 m in the Milk River Basin of Alberta (Kissner 2004).

2.3.2 Hibernacula

Prairie rattlesnake occurrence in the Milk River Basin area is strongly influenced by the availability of suitable hibernacula (over wintering dens). The protection of denning sites is considered critical for the conservation of prairie rattlesnakes (Nicholson and Rose 2001). Without adequate hibernacula sites, rattlesnakes are unable to survive the long, cold winters of northern climates (Watson and Russell 1997). Hibernacula most often occur along river escarpments often in stable slump blocks, meander scarps and fissures, subterranean water channels, sinkholes, and rocky outcrops (Gannon 1978, Watson and Russell 1997, Didiuk 1999). Burrowing animals such as badgers play an important role in creating and maintaining hibernacula sites (Didiuk 1999, Fast and Gates 2003). Didiuk (1999) reported that 8 of 11 den sites on the Canadian Forces Base (CFB) Suffield were coyote or badger burrows.

An underground hole, crevice, mammal burrow or other retreat used as hibernacula generally must be deep and extend to a depth below the frost line (Duvall *et al.* 1985). Hibernacula are most often located on south, east or southeast-facing slopes as these aspects provide maximum solar insolation and protection from prevailing winds (Watson and Russell 1997, Didiuk 1999). Rattlesnakes may return to the same den every year, provided the den is not disturbed or destroyed (Watson and Russell 1997). Consequently, hibernacula may be used by many generations of snakes. Scent trails or pheromones are used to identify past travels and locate denning sites (Watson and Russell 1997). Prairie rattlesnakes have been known to use hibernacula that are shared by bullsnakes, wandering garter snakes (*Thamnophis elegans*) and plains garter snakes (*T. radix*), and occasionally plains hognose snakes (*Heterodon nasicus nasicus*) (Watson and Russell 1997, Kissner 2004). Because large numbers of snakes often den together, the destruction of a single hibernaculum may have a severe impact on snake populations (Kissner 2004).

2.3.3 Gravid Female and Birthing (Rookery) Habitat

Gravid female habitat is strongly associated with a suitable birthing area or rookery (Watson and Russell 1997). Gravid females aggregate at birthing rookeries that are usually close to the denning area, and females seldom move away from these sites (Gannon and Secoy 1985, Watson and Russell 1997). Rookeries are often characterized by the presence of large, flat table rocks overlaying abandoned mammal burrows (Duvall *et al.* 1985). These areas also tend to be associated with greater proportions of sand and shrubs (*i.e.,* silver sagebrush (*Artemesia cana*)) than the surrounding prairie (Fast and Gates 2003). Southeast aspects and presence of burrows (particularly in the absence of rock outcrops or rock piles) are other critical components of gravid female habitat (Fast and Gates 2003). Burrows provide critical shade and shelter from predators and aid in thermoregulation (Graves and Duvall 1993). Rookeries are often used in consecutive years concurrently by several different females (Gannon and Secoy 1985). These females are sedentary and bask in large groups throughout the summer months, and may not feed the year they give birth (Graves and Duvall 1993). Following their birth, neonates (baby snakes) remain in the rookery area until they migrate to hibernacula in September. Females do not provide any parental care to their offspring (Ernst 2002).

2.3.4 Foraging Habitat

Suitable foraging sites tend to be located in native prairie with sagebrush and mammal burrows to provide cover for thermoregulation, escape from predators and ambush locations (Gannon and Secoy 1985, Duvall *et al.* 1985). Burrows are not only used as refugia during periods of inactivity, but may also be the centre around which feeding behaviour is organized (Chizar and Cameron 1996). Rattlesnakes are ambush predators and often occupy burrows waiting for rodents to enter. Due to a relatively short active season for snakes in Alberta, suitable foraging sites need to be available within reasonable distances from hibernacula to allow snakes sufficient time to accumulate reserves for winter hibernation (Watson and Russell 1997). Didiuk (1999) found that most rattlesnakes in CFB Suffield dispersed into the Middle Sandhills and upland prairie habitats from hibernacula along river valleys. Prairie rattlesnakes were also frequently captured in grass terraces along river meanders (Didiuk 1999). Intensive agriculture and rodent control programs reduce the availability of suitable foraging habitat and reduce prey availability for rattlesnakes (Watson and Russell 1997).

2.3.5 Thermal Cover

Snakes are ectothermic (“cold-blooded”) animals meaning that their body temperatures fluctuate with the thermal environment (Russell and Bauer 2000). Most snakes cannot survive exposure to direct sunlight with temperatures over 38 degrees Celsius, or prolonged periods of below freezing temperatures (Duvall *et al.* 1985). Lethal temperatures for snakes depend on the time of exposure. High or low temperatures cause rattlesnakes to seek escape cover or shady areas. Rattlesnakes commonly use burrows, rock piles, bases of sagebrush or dense grass for shade or thermal cover (Didiuk 1999). Treed areas such as cottonwood stands may also be used for thermal relief and cover (Ernst 2002). Road surfaces may provide basking opportunities, increasing the susceptibility of rattlesnakes to road mortality (Kissner 2004).

2.3.6 Area Requirements

Adult males and nongravid females may undertake long migrations into the surrounding valley and upland areas to forage and mate (Gannon and Secoy 1985). While rattlesnakes are known to travel more than 20 km from the denning site, the majority of snakes tend to be found within 15 km of their denning area (river valley or associated coulee) (Nicholson pers. comm.). At the Suffield National Wildlife Area, radio-tagged males and post-gravid females traveled up to 24.7 km from their hibernacula (Didiuk 1999).

3 BULLSNAKE

3.1 Background

The bullsnake is restricted in its occurrence to southern Alberta and southwestern Saskatchewan (Kissner and Nicholson 2003b). The range of this subspecies extends south to northeastern Mexico and west from the Idaho panhandle to western Indiana (Russell and Bauer 2000). In Alberta, bullsnakes occur within the Grasslands Natural Region, primarily in the Dry Mixedgrass and Mixedgrass Subregions (Kissner and Nicholson 2003b). In Alberta, historical records indicate that bullsnakes ranged from the Canada-United States border as far north as Trochu, and east of Calgary to the Alberta – Saskatchewan border (Kissner and Nicholson 2003b). Bullsnakes, like prairie rattlesnakes, are associated with major river valleys such as the South Saskatchewan, Red Deer, Bow, Oldman and Milk Rivers (Kissner and Nicholson 2003b). The bullsnake is designated as a “Sensitive” species in Alberta due to concerns that it may be at risk of decline in the province (SRD 2001a). Although anecdotal evidence indicates a decline in bullsnake populations in Alberta, there is a lack of scientific information about bullsnake population sizes and trends in Alberta and Saskatchewan (Kissner and Nicholson 2003b). Consequently, this species is designated as “Data Deficient” in Canada according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2002). Bullsnakes are commonly misidentified as prairie rattlesnakes due to their similar appearance and habitat use. Bullsnakes can reach over 2 m in length, making it the second largest snake species in Canada (Allen 1996).

There are several limiting factors affecting bullsnake populations in Alberta including natural predation and human persercution. As a “non-license” species, there are no hunting or harvest restrictions for bullsnakes (Kissner and Nicholson 2003b). However, the largest threats to bullsnake populations are thought to be habitat loss and alteration due to agricultural activities, industrial development, and urbanization (Kissner and Nicholson 2003b). As with rattlesnakes, road mortality associated with these types of developments has a significant impact on bullsnakes. For example, Didiuk (1999) reported that 101 of 249 snakes (41%) were found dead on roads over a two year period at CFB Suffield. Road mortality is particularly severe on roads that occur close to hibernation sites along river valleys.

3.2 Ecology

In Alberta, bullsnakes typically emerge from hibernation between late April to mid-June and return to hibernation sites in late August to mid-October (Kissner and Nicholson 2003b). Mating often occurs near the hibernacula in the month of May, after which females move to suitable nesting sites. Bullsnake females generally breed annually unless energy reserves are low in a particular year. Bullsnakes lay between 2 to 24 eggs, with clutch size being partially dependent on the size of the adult female (Russell and Bauer 2000). Females do not incubate their eggs and leave nesting sites shortly after their eggs are laid. In Alberta, neonatal snakes hatch in mid-August to mid-September, following a 50 to 60 day incubation period (Kissner and Nicholson 2003b). The rate of development of the embryo is temperature dependant due to the ectothermic nature of snakes.

3.2.1 Diet

Bullsnakes are considered generalist feeders. Their diet includes small mammals (*e.g.,* rabbits, pocket gophers and ground squirrels), birds, eggs, other reptiles and arthropods (Russell and Bauer 2000). Their diet is very similar to that of rattlesnakes, which are considered competitors in some locations (Jackson 1945). Based on observations at CFB Suffield, snakes migrate to areas of high prey abundance and remain there until the onset of hibernation (Didiuk 1999). At CFB Suffield, snakes migrated to northern pocket gopher burrow complexes. Unlike rattlesnakes, bullsnakes are capable tree climbers, and are regularly observed in trees likely in search of birds, eggs and nestlings (Kissner and Nicholson 2003b). Bullsnakes kill larger prey items by constriction, whereas smaller prey are swallowed alive.

3.2.2 Predators

In Alberta, the bullsnake is preyed upon by a variety of animals including, hawks, badgers, foxes, coyotes, and skunks (Russell and Bauer 2000, Kissner and Nicholson 2003b). Predation on nests can have a significant impant on recruitment in bullsnake populations because eggs are left untended in nests, and several females may lay their eggs in the same nest (Kissner and Nicholson 2003b).

3.3 Habitat Requirements

3.3.1 General

Bullsnakes occur in short and mixedgrass prairies particularly in sandy and brushy areas and in badlands and rocky outcrops along major river valleys (Kissner and Nicholson 2003b). Didiuk (1999) found that bullsnakes at CFB Suffield were predominantly located in grass terrace and grass moraine habitats. Snakes were also frequently captured near old buildings and at the interface of cottonwood (*Populus deltoides*) and silver sagebrush habitats along river valleys.

3.3.2 Hibernacula

Bullsnakes commonly use the same types of hibernacula as prairie rattlesnakes including slump blocks, meander fissures and scarps, sinkholes, rocky outcrops and mammal burrows along major river valleys (Kissner and Nicholson 2003b). Bullsnakes often den with rattlesnakes, but will den in conspecific groups in areas where other snake species are not common. In Alberta, most known bullsnake hibernation sites are located along the breaks and coulees of the South Saskatchewan, Red Deer, Bow, Oldman and Milk Rivers (Kissner and Nicholson 2003b). Like rattlesnakes, bullsnakes select hibernacula on south, east, or southeast facing slopes as these aspects provide protection from prevailing winds and offer maximum solar exposure (Kissner and Nicholson 2003b).

3.3.3 Gravid Female and Nesting Habitat

Because female bullsnakes do not incubate their eggs they must find nesting sites that will provide adequate incubation conditions. Females will excavate nesting sites in sandy or friable soils and often excavate existing burrows of mammals, bank swallows or other bullsnakes. Nesting sites, like hibernation sites, are often located on south, east, or southeast aspects to provide favourable thermal conditions for embryonic development (Kissner and Nicholson 2003b). Nesting sites have been found in Alberta along sandy coulee slopes and slumps along the South Saskatchewan and Red Deer Rivers. Several of these sites are located near hibernation sites. As many as two dozen females were observed at a nesting area in southern Alberta (J. Wright, unpubl.data). Communal nesting behaviour is not uncommon among bullsnakes perhaps indicating that prime nesting habitat is limited or that there is a benefit for females to lay their eggs together (Kissner and Nicholson 2003b).

3.3.4 Foraging Habitat

Bullsnakes are often observed in the same types of habitats as rattlesnakes during the summer months, possibly due to a shared reliance on small mammal prey (Kissner and Nicholson 2003b). As mentioned previously, bullsnakes are adept climbers and are often observed in forested riparian areas along rivers (Kissner and Nicholson 2003b).

3.3.5 Area Requirements

More information is needed to study the area requirements of bullsnakes in Alberta. Few studies have documented home range requirements or daily or seasonal movement patterns of this snake. At CFB Suffield, bullsnakes were reported to travel up to 12 km from hibernacula along the South Saskatchewan River after emerging from hibernation (A. Didiuk, unpubl.data – cited in Kissner and Nicholson 2003b). Bullsnakes generally exhibit a dispersal pattern away from hibernacula along river slopes in May that is similar to that of prairie rattlesnakes (Didiuk 1999).

4 SHORT HORNED LIZARD

4.1 Background

The short-horned lizard, Alberta's only lizard species, is restricted to the extreme southeastern parts of the province (James *et al.* 1997). Short-horned lizards are associated with arid and semi-arid regions of west-central North America. Populations in Alberta are at the northern periphery of their distribution and occur in isolated locations along the Milk and South Saskatchewan Rivers and around the Chin Coulee, 40-Mile Coulee, and Pakowki Lake drainages (James *et al.* 1997, James 2002). Short horned lizards also occur in the extreme south-central portion of Saskatchewan along the Frenchman and Poplar River drainages (James *et al.* 1997). Although more information is needed to assess population sizes and trends, population declines are suspected to have occurred in Alberta and the species is thought to occur at lower densities in the province relative to adjacent populations in the United States (James *et al.* 1997). As populations of short-horned lizards in Alberta are rare, low in abundance, and localized, the species has been classified as “May Be At Risk” of extirpation at the general status level (SRD 2001a). Short-horned lizards were designated as a species of “Special Concern” in Canada in 1992 by COSEWIC (COSEWIC 2002).

Due to its low population density and cryptic habits, it is difficult to accurately assess populations of this species. The most recent population inventory in Alberta was conducted in 2001 and 2002 (James 2002). This survey encompassed all historically recorded short-horned lizard locations in the province. A total of 125 lizards were inventoried in 2001; the average density of lizards was calculated to be approximately 2 animals per hectare (James 2002). Based on lizard capture rates, populations in 2001-2002 generally appeared stable in comparison to previous search efforts (James 2002). However, lizards were not observed at some previously occupied sites, such as the Comrey site within the Milk River Natural Area that was previously noted as being one of the most populous of all sites (Powell and Russell 1992, James 2002). These findings may indicate that local population extinction has occurred and that the distribution of this species in Alberta has contracted (James 2002). Ongoing population monitoring at select locations on an annual basis is required to provide long-term population trend information (James 2002).

Short-horned lizards are limited by both natural and human-related factors. As this species is at the northern edge of their range in Alberta, climatic constraints (*i.e.*, drought and severe winters) have a significant influence on their distribution and may affect productivity and survival rates. Predation is another natural limiting factor, however, losses due to predation are presumed to be minimal (James *et al.* 1997). Human-related threats include habitat loss due to cultivation, oil and gas exploration, roadway development, and urbanization (James *et al.*1997). Habitat degradation or disturbance by livestock grazing is considered a lesser threat (James *et al.* 1997).

4.2 Ecology

Short-horned lizards in Alberta generally emerge in mid to late April and are active until mid-September when they begin to seek hibernacula, or overwintering sites (Powell and Russell 1996). Depending on weather conditions, they may remain moderately active at the overwintering site until late October or early November (Powell and Russell 1993).

Breeding occurs in mid to late May shortly after emergence from hibernation (Russell and Bauer 2000). Females produce one clutch of young per year (James *et al.* 1997). After mating, females remain at the coulee rims while male lizards are reported to disperse into the surrounding short-grass prairie (Russell and Bauer 2000). Females are viviparous and give birth to 6 to 11 young in late July to early August (Powell and Russell 1991, Russell and Bauer 2000). Gravid females are generally restricted to a small home range due to the high energy demand of carrying young (Russell and Bauer 2000). In Alberta, female short-horned lizards are thought to live for approximately five years; the lifespan of male lizards is unclear (James *et al.* 1997). Females breed in their second year, while males become sexually mature in their first year (James *et al.*

1997). There is a pronounced sexual dimorphism in Alberta lizard populations, with male lizards being approximately half the size of females (James 2002).

4.2.1 Diet

Horned lizards have a specialized diet consisting mostly of ants, but they may also eat a variety of other insects such as beetles and grasshoppers (Powell and Russell 1984). Ants are small and contain much indigestible chitin, so that large numbers of them must be consumed. Therefore, the short-horned lizard possesses a large stomach for its body size and a specialized digestive system (Pianka and Parker 1975). Typical prey sizes range from 2.1 mm to 6.0 mm (Powell and Russell 1984).

Horned lizards are small, well camouflaged, sit-and-wait predators that remain motionless until prey comes within striking distance (Pianka 1966). Their main prey items, ants, are frequently clumped in distribution and so can be considered a patchy resource (Powell and Russell 1984). Competition for or shortage of this resource may force short-horned lizards to shift their diet to more of that of a dietary generalist (Powell and Russell 1984). It has been found that increases in the relative density of invertebrate prey does not necessarily increase horned lizard populations (Reynolds 1979).

4.2.2 Predators

Short-horned lizards have flat, rounded bodies, reducing their speed and decreasing their ability to flee from predators (Pianka and Hodge 2002). As a result, natural selection has favoured camouflage, a spiny body form, and cryptic behaviour rather than a sleek body and rapid movement to cover as in the majority of other lizards. Risks of predation are likely to increase during long periods of exposure while foraging in the open. Short-horned lizard predators include loggerhead shrikes, hawks, foxes, coyotes, striped skunks, and a variety of snakes (Smith 1993, Powell and Russell 1996).

4.3 Habitat Requirements

4.3.1 General

In Alberta, short-horned lizards occur predominantly within the Dry Mixedgrass Subregion on sparsely-vegetated, south-facing slopes of coulees and canyons, at the interface between the prairie grassland and the coulee bottom (James *et al.* 1997). In the Milk River Basin, preferred habitat tends to be at the ecotone between the short grass prairie and coulee and canyon margins, although lizards have reportedly been found in coulee bottoms and in open grassland areas (Powell and Russell 1993). Lizards are also found along the southern perimeter of the Cypress Hills plateau on sandy dunes formed from Bearpaw shale, often matted with creeping juniper (*Juniperus horizontalis*) vegetation (Powell and Russell 1993). Short horned lizards appear to be more influenced by habitat structure than vegetative species composition (James 2002). They appear to require a relatively open soil surface (approximately 50% exposed soil), with some vegetative cover (James 2002). Shrub cover (primarily silver sagebrush and creeping juniper) may be more significant to adults, while grasses may be suitable for young lizards (James 2002). Selection of habitat is mostly dependent on suitable sites for thermoregulation, foraging and overwintering.

The HSI model for short-horned lizards in the Milk River Basin included four, equally weighted variables: topographical features; native prairie class; elevation; and riparian zones (Taylor 2004). According to this model, optimal short-horned lizard habitat is restricted to uncultivated areas below 1,100 m that occur within 100 m of valleys (coulees), including valley breaks and bottoms but excluding riparian areas. Other variables that were considered for inclusion in the model were slope and aspect. Short-horned lizards appear to select moderately shallow to moderately steep slopes (10 to 60 degrees) at the microhabitat level. South facing slopes are also typically selected, although lizards along the Milk River have been recorded on other aspects.

4.3.2 Overwintering Habitat

It was initially believed that short-horned lizards utilized crevasses within rock underlying Bearpaw shale to overwinter. However, radiotelemetry has shown that lizards excavate small burrows (approximately 10 cm beneath the surface) in loose soil of south-facing slopes and rely on snow cover for insulation (James *et al.* 1997). Soil around the base of shrubs that has been loosened by the rooting action of the plant may provide suitable burrowing and overwintering sites. Low lizard population densities in Alberta may be the result of high overwintering mortality as a result of seasonal extremes (James *et al.* 1997).

4.3.3 Thermoregulation

Like prairie rattlesnakes and bullsnakes, short-horned lizards are typically found on moderate slopes with south facing exposure (James 2002). These slopes are utilized for their maximum exposure to solar radiation needed to help regulate body temperature. Like other reptiles, short-horned lizards use a behaviour known as “shuttling” where they move between heat sources and heat sinks to control their internal body temperature within a preferred range (Powell and Russell 1985, James *et al.* 1997). By positioning their body in a certain orientation while basking in direct sunlight they are able to increase the surface area to incident radiation. “Thigmothermy” has been observed in short-horned lizards, which means gaining heat from an object (such as a rock) (James *et al.* 1997). Habitat use is generally more varied on sunny days (Powell and Russell 1985a). Shelter, provided by shade from shrubs (*e.g.,* silver sagebrush) or mammal burrows, is required to cool body temperature. Individuals may also burrow into the substrate to seek relief from the heat (Heath 1964). A loose substrate which lizards can burrow into to seek shade or retreat at night is therefore important (Powell and Russell 1996). Vegetation cover is also used to provide overnight cover (James *et al.* 1997).

4.3.4 Foraging Habitat

Short-horned lizards forage in thinly vegetated areas with southern aspects, although lizards have been found on east, west, and some north-facing slopes as well (James *et al.* 1997). Thick vegetation in riparian habitats generally impedes travel through these areas due to the low profile and short legs of horned lizards (James *et al.* 1997). However, risk of predation also tends to increase during long periods of exposure while foraging in the open.

4.3.5 Area Requirements

During the summer, short-horned lizard daily movement patterns rarely exceed 30 m and mostly occur along the slopes of the valleys or valley bottom (Powell and Russell 1996). Radio-telemetry data indicated that short-horned lizards in Alberta do make forays of approximately 70 m from the valley break into the adjoining prairie (Powell and Russell 1996).

Reported home ranges for short-horned lizards in Alberta vary from 4 m^2 to 2,400 m^2 (James *et al.* 1997). Female short-horned lizards generally travel furthest prior to mating, after giving birth, and prior to hibernation (James *et al.* 1997). Females are known to return to similar home range sites annually (Powell and Russell 1994). Males appear to have much larger home ranges and disperse over long distances during the active season (Powell and Russell 1996). Although lizards are not territorial, studies in Alberta have found little evidence of home range overlap (Powell and Russell 1996).

5 GRAZING AND REPTILES

Livestock grazing is the most common human land use over much of the area in which short-horned lizards, prairie rattlesnakes and bullsnakes are found in Alberta (James *et al.* 1997, Watson and Russell 1997, Kissner and Nicholson 2003b, James pers. comm.). Livestock grazing has the potential to affect these reptiles directly either due to disturbance or trampling of adults, young, or eggs (bullsnakes); through direct physical damage to critical habitats; or due to removal of important shelter, thermal or escape vegetation cover (Romero-Schmidt *et al.* 1994). Indirectly, livestock herbivory affects plant species composition and vegetation structure which may influence the community composition or abundance of small mammal or insect prey. Few studies have been done to examine the influence of grazing on these reptiles in Alberta, or elsewhere in their range. The following discussion summarizes the potential interactions of grazing on rattlesnakes, bullsnakes and short-horned lizards based on available studies and discussions with species experts.

5.1 Prairie Rattlesnake and Bullsnake Response to Grazing

Livestock grazing is generally not thought to heavily influence rattlesnake or bullsnake hibernacula as these sites are typically located away from riparian corridors, on moderate to steep, well-drained, xeric, south facing slopes with low forage value (Kissner pers. comm, Nicholson pers. comm.). Cattle tend to avoid rough terrain and steep slopes and typically remain in flatter upland or lowland areas, most often concentrating use near to riparian areas (Van Vuren 1982, Fitch and Adams 1998). However, in order to access riparian areas in valley bottoms, cattle create access trails across steep slopes and will repeatedly use the same trails. If these access trails concentrate trampling and grazing pressure near to hibernacula, slope erosion may result that has the potential to cover up or compress soils at the openings of snake hibernacula (Didiuk 1999). Heavy use along south facing valley slopes can also impede openings of bullsnake nesting burrows if trampling occurs near burrow openings (Didiuk 1999). Grazing along slopes near hibernacula also has the potential to reduce vegetative cover used by gravid female prairie rattlesnakes and their young (Didiuk 1999). Grazing practices that conserve shrub or silver sagebrush cover and limit cattle access near hibernacula will benefit both rattlesnakes and bullsnakes. As snakes are found near dens in the spring and fall, avoiding grazing near hibernacula at these times is considered especially important (Nicholson pers. comm.). Ensuring sufficient shrub cover is retained near hibernacula is important for improving the availability of shade, thermal, and predator escape cover for snakes (Didiuk 1999).

The most significant impact of grazing on rattlesnakes and bullsnakes may be associated with prey abundance in upland native prairie within 15 km of hibernacula (Kissner pers. comm, Nicholson pers. comm.). Grazing practices that promote a greater diversity and abundance of small mammals and retain sufficient cover in foraging sites are considered advantageous to both snake species (Nicholson pers. comm.). Consistent heavy grazing over time has been found to reduce small mammal species diversity and depress populations (Rosenzweig and Winakur 1969, Fagerstone and Ramey 1996). A reduced prey base forces snakes to travel further from hibernacula to forage, making them more susceptible to predation or road mortality (Nicholson pers. comm.). If snakes are unable to accumulate sufficient reserves over the active season they may also compromise their winter survivability (Watson and Russell 1997). Meadow voles and northern pocket gophers, two important rattlesnake and bullsnake prey items have both been correlated with increasing plant biomass and generally occur in higher densities in light to moderately grazed prairie (Fagerstone and Ramey 1996, Reynolds *et al.* 1999). Other important prey, such as Richardson's ground squirrels occur in higher densities in more heavily grazed areas (Fagerstone and Ramey 1996, Michener and Schmutz 2002). Grazing practices that promote vegetation heterogeneity are likely most beneficial to snakes as this will promote a more stable and varied prey base.

Grazing in riparian habitats is unlikely to have a significant effect on rattlesnakes due to their tendency to forage primarily in upland prairie (Gannon and Secoy 1985, Nicholson pers. Comm..). As bullsnakes are known to more commonly use treed areas along river valleys for foraging, they may be more susceptible to riparian grazing effects (Kissner and Nicholson 2003b).

5.2 Short-horned Lizard Response to Grazing

The impact of cattle grazing on short-horned lizard habitat and populations in Alberta is believed to be relatively minimal and may be comparable to the impact bison may have had in the past (Powell and Russell 1993). In general, as short-horned lizards inhabit areas of rough terrain such as steep hillsides and juniper dunes, they tend to occur in areas with little forage value that do not receive much use from cattle (James pers. comm.). According to Powell and Russell (1993), impacts from cattle grazing that are most likely to negatively affect lizards are physical damage near coulee edges as well as seeding of invasive species such as crested wheatgrass (*Agropyron pectiniforme*) that may restrict their movements. As with rattlesnakes and bullsnakes, the possible impacts of cattle use on short-horned lizards may be greatest along heavily used access trails into valley bottoms that traverse south facing slopes. Trampling and soil compression in overwintering areas may make it more difficult for lizards to burrow into the ground. Due to their tendency to remain motionless while foraging or as a predator avoidance strategy, short-horned lizards are more likely to be vulnerable to direct trampling than are snakes (James pers. comm.). Short-horned lizards may be particularly vulnerable to trampling during late July to early August as this is when young lizards are born, and lizard densities are at a peak (James pers. comm.). Due to severe drought conditions in 2001 to 2002, stocking rates were either severely reduced, or cattle were not grazed during the short-horned lizard survey that was conducted in Alberta at this time (James 2002, James pers. comm.). Therefore the effect of cattle use in or near short-horned lizard habitats could not be assessed at that time (James pers. comm.).

Various studies in southern Texas (Burrow *et al.* 2001), southeastern Idaho (Reynolds 1979), western Nebraska (Ballinger and Jones 1985), western Arizona (Jones 1981), and Baja California (Romero-Schmidt and Ortega-Rubio 1999) have examined the influence of livestock grazing on other horned lizard subspecies or other lizard species. Burrow *et al.* (2001) found that habitat selection of Texas horned lizards (*Phyrnosoma cornutum*) in native prairie of southern Texas did not differ with land management treatments (*i.e.*, burning and grazing). Burrow *et al.* (2001) noted that management practices that maximize the availability of a suitable mosaic of bare ground, herbaceous vegetation, and woody vegetation in close proximity may lead to higher lizard densities. Reynolds (1979) found that Pygmy short-horned lizards (*Phyrnosoma douglassi*) responded positively to the reduced vegetative cover caused by sheep grazing due to an increase in availability of basking sites. Pygmy short-horned lizards were most abundant in sheep-grazed areas dominated by big sagebrush (*Artemisia tridentata*). Crested wheatgrass conversion resulted in a significant decrease of these lizards (Reynolds 1979). Ballinger and Jones (1985) also reported a positive relationship between grazing and the maintenance of habitat for two lizard species that occur primarily in open blowout habitats in the sandhill prairies of western Nebraska.

Jones (1981) found that grazing exerted a negative impact on lizard abundance and diversity in western Arizona only when it was associated with significant changes in vegetation structure. Romero-Schmidt and Ortega-Rubio (1999) found that three lizard species exhibited differing responses to grazing in a desert scrub habitat. The sit-and-wait type predator lizard was most negatively affected by grazing due to losses in perennial grass cover and a corresponding reduction in the abundance of certain invertebrates (Romero-Schmidt and Ortega-Rubio 1999). As discussed previously, short-horned lizards have a specialized diet consisting mostly of ants. Intensive grazing by livestock has been shown to have adverse effects on seed-harvester ant species such as *Pogonomyrmex desertorum* due to removal of flowering tillers on grasses and trampling effects on herbaceous annuals. Shrub encroachment, however, can result in increased relative abundance of liquid-feeding ant species (Nash *et al.* 2000).

6 GRAZING SYSTEMS AND PRAIRIE RATTLESNAKE, BULLSNAKE AND SHORT-HORNED LIZARD HABITAT MANAGEMENT

Table III-11 provides an overview of seven grazing systems and their potential implications for maintaining or enhancing habitat for prairie rattlesnakes, bullsnakes and short-horned lizards. A grazing system is a tool used to control the timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003).

Table III-11   Grazing Systems and Reptile Habitat Management

Grazing System	Discussion
Continuous (Season-Long) Grazing	
Advantages:	Under moderate stocking rates, continuous grazing often leads to patch grazing effects in fescue prairie and to a lesser extent in mixedgrass prairie, with areas that are consistently reused and other areas that receive little use. Variably grazed patches may help to create a heterogeneous habitat mosaic. The size and number of patches tends to increase as the season progresses, likely in response to increased grazing pressure (Ring *et al.* 1985). Grazed patches provide short grass habitat that is preferred by Richardson's ground squirrel's (Michener and Schmutz 2002), an important rattlesnake and bullsnake prey. Once established, ground squirrel colonies may be capable of maintaining short grass habitat. Rattlesnakes and bullsnakes are known to remain in areas and exploit patches with an abundance of colonial burrowing prey species (Hill *et al.* 2001). Grazed patches with reduced litter and reduced grass density may also provide unimpeded movement for migrating snakes, depending on patch size. Sagebrush and cacti, both considered unpalatable to cattle, may increase under continuous moderate grazing, increasing the availability of shade and predator escape cover for snakes. Unused patches of vegetation with greater litter cover or more vigorous plant biomass will provide habitat for other snake prey such as meadow voles and northern pocket gophers. A combination of variably grazed patches and unused areas thereby offers habitat to a greater diversity of small mammal prey, likely increasing the stability of this prey base. A heterogeneous physical environment may also provide more habitat patches within which short-horned lizards can forage (Powell and Russell 1984). Habitat management that creates a mosaic of bare ground, herbaceous vegetation and woody vegetation in close proximity will likely benefit short-horned lizards (Burrow *et al.* 2001). By reducing forb and grass cover, grazing in sagebrush habitats increases the availability of basking sites for lizards (Reynolds 1979, James 2002). Short-horned lizards in Alberta tend to use patches with at least 50% exposed soil (James 2002). An increase in sagebrush or shrub cover as a result of grazing may also be beneficial to short-horned lizards that rely on this cover for shade and overnight thermal cover. Loosened soil around the base of shrubs is thought to provide suitable sites for burrowing into for overwintering (James *et al.* 1997). Availability of sagebrush or shrub cover may also benefits populations of liquid-feeding ant prey (Nash *et al.* 2000).
Disadvantages:	Riparian areas are often heavily impacted by persistent cattle use under continuous grazing systems particularly if alternate water supplies or fencing is not in place. Continuous grazing nearly always results in overuse of riparian areas (Ohmart 1996, Fitch and Adams 1998). Overuse of riparian areas has the potential to impact stability of banks and slopes associated with waterways. Slumping of banks and slopes may impact snake hibernacula or bullsnake nesting sites depending on the position of these sites on the slope (Kissner pers. comm.). However, little information is available about bullsnake nesting sites, and only a few sites have been found in Alberta (Kissner pers. comm.). Grazing during the spring and fall when snakes are basking near hibernacula may increase the vulnerability of snakes to predators if it significantly reduces important cover habitat around the hibernacula (Nicholson pers. comm.). This is particularly a concern in grass terrace habitats along river floodplains and escarpments (Didiuk 1999). Didiuk (1999) reported that rattlesnakes and bullsnakes at CFB Suffield remained near hibernacula for prolonged periods in the spring and fall. Under continous grazing, cattle are often grazed throughout the growing season beginning in the spring and continuing throughout the summer and fall periods. Reductions in silver sagebrush density and canopy cover may occur under heavy stocking rates with confined livestock feeding (Adams *et al.* 2004).

Grazing System	Discussion
Deferred Grazing	
Advantages:	Deferred spring grazing has the advantage of minimizing possible grazing or trampling disturbance to river banks and slopes when high water tables and runoff make them more susceptible to erosion. This minimizes erosion and slumping risks to hibernacula and nesting sites. Grazing on dry mixedgrass or mixedgrass prairie that defers use until after seed set would likely promote habitat use by small granivorous mammals that prairie rattlesnakes and bullsnakes prey upon (Fagerstone and Ramey 1996).
Disadvantages:	If grazing were deferred long enough in the growing season, the increased height and density of vegetation may discourage use by burrowing mammals, particularly Richardson's ground squirrels, and impede snake movement through the prairie.
Complementary Grazing	
Advantages:	As with deferred grazing systems, complementary grazing allows for improved plant vigour in grasses and increases the likelihood of seed set. Using seeded pasture in the spring to defer the use of native prairie where river systems occur will allow banks to stabilize following spring runoff before cattle graze these areas.
Disadvantages:	Complementary grazing requires the use of seeded pasture which may not be available in all grazing systems. Seeded pasture is often not suitable in many places in the mixedgrass and dry mixedgrass prairie due to fragility of soils and dry conditions. Seeding native prairie is also not desirable as the taller growth form of most exotic forage species may impede snake and lizard movements. Reynolds (1979) noted a significant decrease in abundance of short-horned lizards in sagebrush prairie that had been converted to crested-wheatgrass in southeast Idaho.
Rotational Grazing	
Advantages:	Rotational grazing systems including switchback, deferred-rotation and rest rotation grazing allow for timed sequences of grazing and rest periods in smaller sized pastures (Holechek *et al.* 2003). Rotational grazing reduces selective grazing by encouraging use of plant groups differing in their season of growth and allows for seed production, seedling establishment and restored plant vigour (Adams *et al.* 1991). Vigorous grasses with high seed production attract small granivorous mammals such as mice (Fagerstone and Ramey 1996). Richard's ground squirrels consume leaves and stems of grasses, and a variety of forbs in early spring and summer, but seeds are their principal foods in late summer and autumn (Quanstrom 1968). Vegetation on south facing slopes of river valleys with moderate to steep gradients, the preferred habitat of short-horned lizards, is generally maintained by topography. Rapid drainage and erosion keep vegetation fairly sparse. However, excessive use by livestock may destabilize these slopes. Periodic rest from grazing with rotational grazing systems allows vegetation to maintain vigour and deep roots to prevent the acceleration of erosion. Rotational grazing systems also offer a means to control the timing of grazing in critical habitats to avoid sensitive periods. This includes avoiding use near hibernacula in the spring and fall and avoiding use near short-horned lizard birthing areas in late July to early August.
Disadvantages:	A noted disadvantage due to rotational grazing is the creation of uniform grazing effects due to improved cattle distribution. Uniform grazing effects are accentuated when high stocking rates are used, forcing cattle to use the entire area available for grazing. Prairie rattlesnakes tend to favour heterogeneous grassland conditions with high species diversity (Gannon 1978). Vegetation heterogeneity increases small mammal prey species diversity for rattlesnakes and bullsnakes and is also important for promoting a diverse invertebrate prey base for short-horned lizards (Fagerstone and Ramey 1996, Jonas *et al.* 2002).

Grazing System	**Discussion**
Intensive Grazing	
Advantages:	Intensive grazing in upland foraging sites may reduce the cover of vegetation increasing the occurrence of some snake prey species such as Richardson's ground squirrels. Heavy grazing will also increase the relative composition of unpalatable shrubs including sagebrush.
Disadvantages:	Intensive grazing at high stocking rates tends to reduce biodiversity of the area, thereby reducing the variety of potential prey for snakes (Bai *et al.* 2001). In particular, consistent heavy grazing is known to depress populations of most small mammals, especially species such as meadow voles and northern pocket gophers that require greater vegetation cover (Fagerstone and Ramey 1996). The potential for negative impacts to riparian areas is also heightened with high stocking rates. Heavy use in and around riparian areas increases the probability of slumping, erosion or soil compaction that may occur in the vicinity of hibernacula or bullsnake nesting sites (Didiuk 1999). Over-wintering sites are often located on slump zones and are therefore prone to erosion (Nicholson and Rose 2001). Heavy use also increases trampling risks to short-horned lizards (James pers. comm.).
Riparian Area Grazing	
Advantages:	Hibernacula are often associated with sagebrush patches along river valleys (Nicholson and Rose 2001). The sagebrush/western wheatgrass (*Agropyron smithii*) habitat type in riparian areas is a disturbance-caused (disclimax) habitat type where site potential has been altered by prolonged heavy grazing (Thompson and Hansen 2001). Therefore, continued grazing in riparian areas may be necessary to maintain this habitat type. Rattlesnakes occasionally use riparian areas, but they are generally more important foraging areas for bullsnakes and garter snakes (Didiuk 1999). Well-managed riparian areas may result in sustained production of woody vegetation, such as cottonwoods, that are used by bullsnakes as foraging habitats. Avoiding grazing in the spring when banks are vulnerable to erosion may benefit the conservation of suitable hibernacula. Trailing action and grazing by cattle, especially in spring, tends to destabilize slopes. Short-horned lizards generally do not use riparian areas as thick vegetation impedes their movements (Taylor 2004, James pers. comm.).
Disadvantages:	Restricting use of riparian areas may concentrate heavier grazing in upland habitats and lead to uniform grazing effects or diminished habitat opportunities for a diverse small mammal prey base for snakes.

7 BENEFICIAL MANAGEMENT PRACTICE RECOMMENDATIONS

Grasslands, sand dunes, shrub lands and river escarpments in the Milk River Basin provide important and unique habitat for rattlesnakes, bullsnakes and short horned lizards (Didiuk 1999). Maintaining critical native prairie habitats, in particular, minimizing disturbance to south, southeast and east facing slopes that provide overwintering habitat, is important to the long-term conservation of these reptiles.

The following general land use and grazing recommendations offer a variety of means to protect or maintain prairie rattlesnake, bullsnake and short-horned lizard populations or their critical breeding, foraging, thermal, and overwintering habitats within the Milk River Basin. These recommendations apply to the full-extent of their range within the Grassland Natural Region of Alberta. Further research (Section 8) is required to gain a better understanding of the ecology and population dynamics of these reptiles as well as to better understand the influence grazing has on these species, their critical habitats and their primary prey.

7.1 General Recommendations

Native prairie conservation

- Retain native prairie and avoid cultivation or development along major river valleys, coulees or drainages and associated uplands where prairie rattlesnakes, bullsnakes and short-horned lizards occur (Kissner 2004, Kissner and Nicholson 2003b, Taylor 2004).
- Natural environments provide important habitat for the majority of reptiles and amphibians in Alberta (Cottonwood Consultants 1986). Cultivation of native grasslands is considered a major threat to prairie rattlesnakes, bullsnakes and short-horned lizards (Cottonwood Consultants 1986, Taylor 2004, James pers. comm.). Cultivation can result in direct mortality of these species and reduces or locally eliminates colonial small mammal populations and their burrows that are an important source of food and shelter for bullsnakes and rattlesnakes. Tall and dense cropland or seeded pasture vegetation may also render areas unsuitable to snakes and lizards by impeding their movement and dispersal across the landscape.
- Maintain low to moderate shrub densities (in particular sagebrush flats) in native prairie along river valleys, coulees or drainages in prairie rattlesnake, bullsnake and short-horned lizard habitats. Shrub cover (in particular sagebrush cover) is an important component of rattlesnake and bullsnake foraging habitats (Didiuk 1999, Kissner 2004). Sagebrush vegetation also aids in thermoregulation and provides shelter for snakes and short-horned lizards.

Pest control

- Avoid the use of insecticides or herbicides in marginal agricultural areas within the vicinity of short-horned lizard, bullsnake and prairie rattlesnake habitats. These products can reduce the availability of insect or rodent prey or result in bioaccumulation of toxins in prey species (FWD 1990, Cotterill 1997). The use of these chemicals may be especially harmful to short-horned lizards as their diet consists mainly of insects such as ants, grasshoppers, crickets and beetles (James *et al.* 1997).

- Discourage the use of poisoning programs to control high densities of Richardson's ground squirrels or northern pocket gophers. Rodent poisoning reduces the available prey base for rattlesnakes and bullsnakes and may result in indirect poisoning of these reptiles. Small mammals are not only an important food source, but their burrowing activities provide important snake refugia (Gannon and Secoy 1985, Chizar *et al.* 1996). Encourage alternative ground squirrel population control strategies such as promoting snakes and other natural predators as biological control agents. Investigate vegetation management techniques, such as retaining greater amounts of taller and denser grassland patches to manage ground squirrel populations at appropriate densities (Michener and Schmutz 2002).
- Maintain viable badger populations in rattlesnake and bullsnake habitats (Didiuk 1999, Fast and Gates 2003). Badgers play an important role in either creating suitable snake dens or keeping burrow entrances of hibernacula open where slopes are unstable (Didiuk 1999). Badger burrows also appear to be a critical component of gravid female rattlesnake habitat (Fast 2003).

Key habitat protection and industrial development mitigation

- Avoid disturbance (from human activities or developments) to sparsely vegetated south, southeast or east facing slopes and slump areas along river valleys, coulees, and major drainages at any time of the year (Didiuk 1999, James 2002). These areas provide critical overwintering habitat to short-horned lizards, prairie rattlesnakes and bullsnakes.
- Protect known and high potential bullsnake and prairie rattlesnake hibernacula sites from disturbance and development. Continued availability of "safe" hibernacula is considered the most critical limiting factor for snakes in Alberta (Cottonwood Consultants 1986). Large aggregations of snakes in these dens are extremely vulnerable to disturbance and "catastrophic events" such as human persecution or flooding (Didiuk 1999). Destruction of hibernacula can therefore have a significant impact on local and regional populations (Didiuk 1999). Snakes occupy hibernacula from early October to late April each year. At CFB Suffield, rattlesnakes and bullsnakes had prolonged periods of remaining near hibernacula in the spring and fall, increasing their vulnerability to human disturbance of these sites.
- Abide by setback distances and timing restrictions recommended by SRD, Fish and Wildlife Division for human activities, including industrial development near to prairie rattlesnake hiberacula and suitable short-horned lizard habitat (SRD 2001b). SRD recommends a 200 m, year-round setback for short- and long-term vegetation disturbance activities from prairie rattlesnake hibernacula. This includes seismic activities and wellsite, powerline, pipeline, battery and road construction. There is a 100 m year-round setback recommended from short-horned lizard suitable habitat.
- Known hibernacula sites in Alberta are listed in the provincial Biodiversity / Species Observation Database (BSOD). Landowners should be encouraged to contribute information to this database.
- The Milk River Basin HSI maps developed for short-horned lizards and prairie rattlesnakes should be used to inform environmental planning of oil and gas activities to ensure high potential key habitats are avoided. Once additional information is available, an HSI model should be developed for bullsnakes.

- Exact locations of hibernacula and critical short-horned lizard habitat are considered highly sensitive data and its use should be carefully managed (Didiuk 1999, James 2002).
- In areas with suitable rattlesnake and bullsnake habitat, oil and gas companies should routinely monitor and remove snakes from pipeline trenches (Didiuk 1999).
- Given the extreme vulnerability of short-horned lizard populations to disturbance events, and the sensitivity of the habitats they occupy to erosion damage, oil and gas developments should be avoided in critical short-horned lizard habitats (James 2002). Oil and gas developments not only disrupt sensitive habitat, but can also potentially open-up lizard habitats to recreational users and increased traffic mortality.
- If oil and gas activity must occur in an area populated by short-horned lizards, James (2002) suggests that activity should occur away from coulee rims and on more densely vegetated, northerly –facing slopes (if it is necessary to traverse slopes). If short-horned lizards are found within an area of activity, James (2002) recommends that they be moved at least 100 m away from the area of activity.
- Conduct pre-development wildlife surveys in areas of suitable habitat to locate potential prairie rattlesnake and bullsnake hibernacula and short-horned lizard populations. To search an area with high potential to harbour short-horned lizards, survey protocol guidelines outlined by James (2002) should be observed. These include using experienced or trained field biologists; conducting surveys in late July or early August (when young are born); prioritizing search efforts in high potential habitats; allocating sufficient time to search efforts; and ensuring searching is conducted in appropriate weather conditions.
- Oil and gas activities in rattlesnake, bullsnake or short-horned lizard habitats should observe methods to minimize disturbance to native prairie and ensure appropriate reclamation.

Road mortality

- Suggested methods to reduce road-kill of snakes include (Didiuk 1999, Rose 2001):
- avoid development of paved roads near and parallel to major river valleys in the vicinity of known or potential hibernacula;
- redirect traffic away from existing roads along valleys near known or potential hibernacula;
- where possible, schedule industrial development and associated traffic before May, or from mid-June to mid-August and after September near known or potential hibernacula;
- night-time traffic will have less impact as snakes move less at night and only when it is warm enough;
- implement traffic speed controls and snake crossing signs in areas with high densities of snakes and along key dispersal corridors;
- in high mortality zones, implement snake and small mammal underpasses, where possible.
- Short-horned lizards are also highly susceptible to road mortality as lizards remain motionless as a defense mechanism and their small size and camouflage make them very difficult to detect (James *et al.* 1997). To minimize possible road mortality of short-horned

lizards, avoid or limit road development, recreational motorized vehicle activity, and industry traffic along coulees and river valleys in high potential short-horned lizard habitats.

Flooding

- Avoid creation of reservoirs or dams along major rivers in southeastern Alberta to avoid flooding prairie rattlesnake and bullsnake hibernacula and critical short-horned lizard habitat (James *et al.* 1997, Didiuk 1999).

Public Awareness and Intentional Persecution

- Intentional persecution including killing of snakes and den vandalism are considered significant limiting factors for both bullsnakes and prairie rattlesnakes (Watson and Russell 1997, Kissner and Nicholson 2003b). Public awareness and education campaigns are thought to be an important means to improve the public perception of snakes and inform people about how to avoid or appropriately deal with snake encounters (Kissner and Nicholson 2003b). Public outreach programs could be modeled on initiatives such as the Lethbridge Rattlesnake Conservation Project (Ernst 2002). Teaching the public about the biology and natural history of snakes can increase appreciation for snakes. It is also important to promote the benefits of bullsnakes and prairie rattlesnakes as small mammal control agents (Diller and Johnson 1988, Didiuk 1999).
- Short-horned lizards, as a curiosity item, may face a greater threat from collectors than from intentional persecutors. As a "non-game" species, short-horned lizards are fully protected under the *Wildlife Act*. Initiatives are needed to inform the public and industry about the vulnerable nature of short-horned lizard populations and their sensitivity to disturbance.

7.2 Grazing Recommendations

Grazing systems that will benefit bullsnakes, prairie rattlesnakes and short-horned lizards should aim to:

- maintain the integrity of, or limit impact to key habitat components (hibernacula, nesting sites or gravid female habitat); and
- enhance the suitability of summer foraging sites by creating a patchy landscape with moderate shrub cover (*i.e.,* sagebrush), open basking sites, and a diversity of cover types to promote the diversity, abundance, and long-term stability of small mammal and invertebrate prey populations.

Although prairie rattlesnakes are known to travel up to 25 km, the majority of rattlesnakes and bullsnakes occur within 15 km of hibernacula areas in river valleys or associated coulees (Didiuk 1999, Nicholson pers. comm.). Grazing in uplands within this 15 km zone is most likely to influence the health, integrity or sustainability of prairie rattlesnake and bullsnake foraging sites (Kissner 2004, Nicholson pers. comm.). Grazing within 100 m of valleys (including coulees and valley breaks and bottoms) has potential to impact short-horned lizard habitats (Taylor 2004). Grazing within 1 km to 5 km of rivers, coulees and drainages has greatest potential to impact bullsnake or rattlesnake hibernacula, nesting sites or gravid female habitat (Kissner 2004, Kissner and Nicholson 2003b). Grazing directly along riparian channels is unlikely to have a significant impact on short-horned lizards or prairie rattlesnakes, but may impact foraging opportunities for bullsnakes (Kissner and Nicholson 2003b).

Final decisions regarding the type of grazing system that is most appropriate and calculation of suitable stocking rates that would benefit prairie rattlesnakes, bullsnakes and short-horned lizards need to be made on a case by case basis. Local conditions need to be considered including vegetation type, range condition and health, as well as the distribution and location of valued habitat components across the landscape. No one grazing system can be universally applied, and each must be tailored to local environmental conditions. Control and flexibility over stocking rates and dispersion of livestock use are two key properties of an optimum grazing system. Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

The following grazing recommendations discuss key management principles that will benefit bullsnakes, prairie rattlesnakes and short-horned lizards based on available knowledge of their ecology and habitat requirements.

- Prevent cattle induced slope erosion or trampling along south facing slopes near known or high potential bullsnake or prairie rattlesnake hibernacula sites (Didiuk 1999). Monitor the proximity of cattle access trails to these critical overwintering sites. Where necessary, use fencing to exclude cattle from areas with known hibernacula or areas with high potential to harbour suitable hibernacula (Didiuk 1999). Fencing or salt placement can also be used to redirect cattle along alternate access routes into riparian corridors that will not impact critical overwintering sites.
- Avoid grazing near bullsnake and prairie rattlesnake hibernacula in the spring (April to June) and fall (September to October) (Kissner pers. comm., Nicholson pers. comm.). Snakes will congregate and bask near hibernacula at these times (Didiuk 1999).
- Maintain essential vegetation cover (*i.e.,* sagebrush or dense grass) near hibernacula and gravid female prairie rattlesnake habitat. Assess and monitor the impact of cattle grazing on this vegetation.
- To reduce risks of trampling to young individuals, avoid concentrating cattle use near to known or potential prairie rattlesnake gravid female habitats, bullsnake nesting areas or short-horned lizard birthing sites in the late summer (from August to September).
- Place salt or stock water at least 200 m away from river escarpments, coulee edges and south facing valley slopes (Kissner pers. comm., Nicholson pers. comm.).
- Avoid spring grazing near slopes and in riparian areas when soils are moist and more susceptible to slumping. This will help to maintain slope stability near hibernacula or bullsnake nesting areas.
- Avoid continuous heavy grazing in rattlesnake, bullsnake or short-horned lizard habitats (including upland and riparian sites). Consistent heavy grazing, increases trampling risks and is more likely to result in slope damage and erosion that could affect hibernacula. In riparian areas, continuous grazing can reduce plant species diversity and eliminate woody vegetation

cover. This may have detrimental impacts to bullsnake foraging habitats or to thermal cover areas used by rattlesnakes (Didiuk 1999, Kissner and Nicholson 2003b). In upland habitats, continuous heavy grazing can depress populations of most small mammals, reduce diversity of prey species, as well as diminish shelter and thermal vegetative cover that is important to bullsnakes and prairie rattlesnakes.

- Promote rotational or deferred grazing systems to control the timing of cattle grazing in critical reptile habitats to avoid use near hibernacula or birthing areas in the spring and fall. These grazing systems also allow for improved plant vigour in grasses and increase the likelihood of seed set. This benefits cover and foraging opportunities for small mammals and insect prey, including seed-harvester ant species (Fagerstone and Ramey 1996, Nash *et al.* 2000). Rotational or deferred grazing systems are generally recommended to maintain or improve the condition of dry mixedgrass and mixedgrass prairies particularly in areas with sandy soil range sites.
- Use light to moderate stocking rates to promote patchy grazing and heterogeneous vegetation heights, with areas of heavy, moderate, light and no use. Richardson's ground squirrel habitat and snake basking sites are created in more heavily used areas. Areas with taller vegetation and denser litter cover provide shelter for rattlesnakes and bullsnakes and also provide suitable cover types to a greater diversity of prey.
- A proper use factor of 50% is recommended for sustaining productive mixedgrass and dry mixedgrass prairie, respectively (Adams *et al.* 1994).
- Adjust stocking rates in accordance with range condition. Reduce stocking rates during drought periods.

8 RESEARCH RECOMMENDATIONS

To inform management decisions, additional research is needed to characterize the key habitat needs, foraging requirements, and dispersal patterns of prairie rattlesnakes, bullsnakes and short-horned lizards. Research is also needed to study the effects of widespread land use activities (*i.e.,* cattle grazing) on these species. Few studies of this kind have been done to date. Recent advances have been made to confirm historical hibernacula locations, locate new hibernacula, inventory populations and develop long-term population monitoring protocols for prairie rattlesnakes and short-horned lizards (Rose 2001, Nicholson and Rose 2001, James 2002, Fast 2003). Comparatively, bullsnakes have been poorly research in Alberta (Kissner and Nicholson 2003b). The recently initiated provincial road-kill monitoring program for snakes may improve knowledge regarding the distribution of bullsnakes and rattlesnakes in Alberta and their habitat preferences (ESCC 2000).

The goal of grazing management research should be to assess exactly how much of an impact livestock grazing is having on critical reptile habitat components (including hibernacula, nesting or birthing sites, thermal cover and foraging habitat), and to determine which grazing strategies (*i.e.,* timing, distribution, stocking rates) are most beneficial or are most effective at mitigating negative impacts.

Key research needs are described below for each species.

8.1 Rattlesnake

- Continue efforts to conduct long-term population monitoring of prairie rattlesnakes following suggestions provided by Rose (2001). Snake counts at hibernacula are the easiest means to monitor snake populations, but they do not necessarily provide accurate estimates of population sizes. Mark and recapture studies are required in order for population sizes and trends to be accurately measured (Nicholson pers. comm., Kissner pers. comm.).
- Continue efforts to locate and map out rattlesnake hibernacula to protect these sites from development pressures (Nicholson and Rose 2001, Rose 2001, Fast 2003). Remote sensing and GIS based models have proven useful in the location of new hibernacula (Nicholson and Rose 2001).
- Further investigate the characteristics of vegetation present at den sites (Rose 2001).
- Confirm the characteristics of rookery habitat for gravid female rattlesnakes (Didiuk 1999). This includes determining the movement radius of gravid females from dens and analyzing their habitat selection (Fast and Gates 2003). This information is needed to ensure that recommended setback distances from hibernacula ensure that gravid females are not disturbed (Fast 2003).
- Continue research to assess the activity patterns of rattlesnakes to better understand its thermal ecology, diet, and habitat requirements (Watson and Russell 1997, Didiuk 1999). A research initiative is presently underway to assess dispersal patterns and foraging of prairie rattlesnakes in upland prairies in relation to land use in southeastern Alberta (Jorgensen pers. comm.).
- Information from the snake road-kill monitoring program should be used to guide mitigation efforts to reduce the frequency of road mortality (ESCC 2000). This monitoring program can also help to assess the magnitude of road-induced snake mortality and better understand prairie rattlesnake and bullsnake dispersal patterns and habitat use.
- Research the relative importance of northern pocket gophers and Richardson's ground squirrels and their burrows as a source of food for prairie rattlesnakes (and bullsnakes) and as summer and winter shelter (Didiuk 1999).
- Evaluate the impact of rodent poisoning on rattlesnake and bullsnake populations.
- Assess high potential and known hibernaculum sites for erosion damage and reduced vegetation cover due to cattle grazing (Rose 2001). Assess the role of cattle in causing slumping that creates new hibernacula sites for snakes.
- Assess the impact of cattle grazing on gravid female habitats. Evaluate the frequency and intensity of cattle use in these habitats.
- Evaluate small mammal prey densities in varying land use types, including land managed under different grazing systems or grazing intensities (including ungrazed habitat).

8.2 Bullsnake

- Collect additional baseline data on bullsnake population parameters to establish population sizes and trends in Alberta (Kissner and Nicholson 2003b).
- Research habitat use, dispersal patterns, and habitat requirements of the bullsnake (Didiuk 1999, Kissner and Nicholson 2003b). At present there is little information available on

specific habitat requirements of this species across its range in Alberta. In particular, little information is available regarding the characteristics of communal bullsnake nesting habitats. Radio-telemetry studies as opposed to simple trapping studies can provide valuable data on the amount of time spent in certain habitats, what activities are carried out in each habitat, and provide information on the combination of habitat types that are used by snakes (Kissner and Nicholson 2003b). This technique can also be useful for locating hibernacula and nesting sites.

- Research the effects of grazing on bullsnake nesting sites and hibernacula. The potential for grazing to impact bullsnake upland and riparian area foraging habitats also requires further study.

8.3 Short-horned Lizard

- Continue efforts to monitor short-horned lizard populations and determine population trends as recommended by James (2002), with annual surveys conducted at select locations and less frequent surveys conducted in outlying areas.
- Evaluate the overlap of cattle grazing activities and short-horned lizard distribution.
- Determine the impact of livestock on critical short-horned lizard overwintering habitats.
- Assess the role of grazing in maintaining suitable microsites for short-horned lizards (*i.e.,* maintaining basking sites with reduced forb and grass cover) (Reynolds 1979)
- Assess the potential impact of trampling as a source of mortality among juvenile and adult short-horned lizards.
- Assess the use of cattle trails as dispersal corridors for short-horned lizards in upland or lowland areas.

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B: PLAINS HOGNOSE SNAKE, PLAINS SPADEFOOT TOAD AND GREAT PLAINS TOAD

1 INTRODUCTION

The purpose of this report is to summarize and compare the ecology and habitat requirements of three herpetofauna (amphibian and reptile) species that occur in similar habitats within the Milk River Basin: the plains hognose snake (*Heterodon nasicus nasicus*), plains spadefoot toad (*Spea bombifrons*) and the great plains toad (*Bufo cognatus*). Based on this information, the potential effects of grazing and various grazing systems on these species, their critical habitats and their prey are discussed. This discussion is followed by a summary of recommended beneficial management practices to enhance or protect these species and their habitat in the Milk River Basin and throughout their range in southeastern Alberta. Lastly, several research recommendations are presented that would help to better understand these species and their response to management practices.

Plains hognose snakes, plains spadefoot toads and great plains toads reach the northern extreme of their North American range in southeastern Alberta, southern Saskatchewan and the extreme southwest corner of Manitoba. These species are all adapted to arid mixedgrass and dry mixedgrass prairie regions with sandy soils. Their ability to burrow deeply into sandy soils affords them protection from drought and predators, and provides suitable overwintering habitat. All three of these species are listed as “May Be At Risk” of extirpation in Alberta due to their rarity, suspected population declines and their sensitivity to habitat disturbances (Alberta Sustainable Resource Development (SRD) 2001a). All three herpetofauna are designated as “non-game animals” under Alberta’s *Wildlife Act*, and are therefore protected from hunting or collection. Hognose snake dens are also protected from disturbance between September 1 to April 30 under the *Wildlife Act.* Hognose snakes, spadefoots and great plains toads have not been extensively studied in Alberta and ongoing monitoring is necessary to accurately assess their distribution, population trends, habitat requirements and response to land management practices. Livestock grazing is the dominant land use within the ranges of these species in the Milk River Basin. An understanding of the potential impacts of grazing and associated land use activities on these species and their habitats is therefore important for their management and long-term conservation. It is also important to consider strategies to minimize potential impacts due to other human activities, such as industrial development, which can pose a risk to these species or their habitats.

2 PLAINS HOGNOSE SNAKE

2.1 Background

The plains hognose snake is the subspecies of western hognose snake that occurs in southeastern Alberta (Wright 1998). The hognose snake derives its name from a sharply upturned rostral scale (Wright 1998). This species is considered extremely rare in Alberta, with fewer than 100 sites or specimen records documented in the province (SRD 2001a). Consequently, this species is listed as "May Be At Risk" of extirpation in Alberta at the general status level (SRD 2001a). The occurrence of hognose snakes in Alberta is loosely associated with the major river drainages in the extreme southeast of the province. Some evidence exists that indicates that there are two separate, north and south populations of this snake in Alberta (Wright 1998). The "south population" occurs in the Milk River Canyon / Wild Horse / Manyberries region and is contiguous with a Montana population (Wright 1998). The "north population" is found along the South Saskatchewan River from Medicine Hat to Empress (Wright 1998). This species also occurs through southwestern Saskatchewan, west of the Missouri Coteau (Wright 1998). A relict population is found in the sandhills of southwest Manitoba (Leavesley 1987). In the United States, this species occurs from North Dakota east to Minnesota, west to Montana, and south to northern Texas and west central New Mexico (Wright 1998).

More information is needed to determine hognose snake population sizes and trends and to accurately map out the range of this species in Alberta. The apparent scarcity of this species may be due to its secretive behavior and misidentification as the bullsnake (*Pituophis catenifer sayi*) or the prairie rattlesnake (*Crotalus viridis viridis*). An increasing number of records in recent years indicates that this species may exist in greater numbers than previously believed (Wright 1998).

Although more research is needed, factors that are thought to be limiting to the plains hognose snake include habitat loss or alteration, industrial and agricultural activities, roads, intentional persecution, and the availability of suitable sandy habitat (Wright 1998).

2.2 Ecology

Plains hognose snakes emerge from hibernation in late April or early May and remain active for approximately 133 days, until mid-September (Pendlebury 1976). Hognose snakes reenter hibernation in the fall in late September, and possibly into early October (Wright 1998). This species has a diurnal activity pattern, and is most active during the mornings and evenings on sunny days when air temperatures range between 10 degrees to 20 degrees Celsius (Wright 1998). The mating season occurs in the spring, and the egg laying period in Alberta often extends from the second week of June to the last week of July (Wright 1998). During this period females lay between 4 and 23 eggs, with a mean clutch of approximately 9 eggs (Russell and Bauer 2000). Clutches are produced every other year, and are incubated for 60 days (Russell and Bauer 2000).

2.2.1 Diet

Toads are considered the main food item for hognose snakes (Wright 1998). Other prey items include frogs, lizards, garter snakes, salamanders, tadpoles, lizard eggs, snake eggs, small birds and various small rodents (Pendlebury 1976, Russell and Bauer 2000). The young of northern pocket gophers (*Thomomys talpoides*) and thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) are also thought to be important prey items (Wright 1998). At the Canadian Forces Base (CFB), Suffield, hognose snakes were captured with the greatest frequency in areas where northern pocket gophers were common. It is not clear whether this snake also favours

Richardson's ground squirrel (*Spermophilus richardsonii*) colonies, as this rodent was absent on the study area at Suffield (Wright 1998, Didiuk 1999).

2.2.2 Predators

Little is known about the effect of predation on hognose snake populations in Alberta (Wright 1998). Striped skunks (*Mephitus mephitus*), badgers (*Taxidea taxus*), coyotes (*Canis latrans*) and red-tailed hawks (*Buteo jamaicensis*) are known predators of snakes or snake eggs that occur within the hognose snake range in Alberta (Wright 1998).

2.3 <u>Habitat Requirements</u>

2.3.1 General

The plains hognose snake occurs within the Dry Mixedgrass and Mixedgrass Natural Subregions of southeastern Alberta (Wright 1998, Russel and Bauer 2000). The hognose snake prefers the dry prairies, particularly those with friable, sandy soils and sparse vegetation (Pendlebury 1976, Russell and Bauer 2000). According to Russell and Bauer (2000, p.96) this species "is found in sandy or gravelly areas with low-growing plants, sandhills, dry stream bottoms, often near areas of water in typical badlands country". Recent records from CFB Suffield (1994 to 1997) show that the plains hognose snake occurs in more diverse habitat than formerly believed. Specimens from CFB Suffield were collected on open prairie with either sandy substrate, heavy sod, or near sloughs; on gravelly rolling glacial till plain; open dune sandhill country; and on a riparian sageflat with densely packed soils (Wright 1998). Two road-kill specimens were also recently collected northeast of Medicine Hat, one along a gravel road bordered by overgrazed rangeland with heavy sod; the second along a major highway bordered by canola fields with a 20 m grassy right-of-way (Wright 1998). Cultivated land is not considered suitable hognose snake habitat (Wright 1998). Ditches and rights-of-way along fields and roads likely represent important dispersal corridors for these snakes, however, more research is needed to confirm this hypothesis (Wright 1998).

In Alberta, the plains hognose snake has been found in association with needle-and-thread (*Stipa comata*), sand dock (*Rumex venosus*), prickly rose (*Rosa acicularis*), choke cherry (*Prunus virginiana*), silver sagebrush (*Artemisia cana*), cushion cactus (*Mamillaria vivipara*) and prickly pear cactus (*Opuntia polycantha*) (Pendlebury 1976).

2.3.2 Hibernacula

Plains hognose snakes either use existing rodent burrows as hibernacula, or dig their own burrows (Wright 1998). Occasional records have documented plains hognose snakes denning in communal hibernacula with other snake species (such as prairie rattlesnakes, bullsnakes or gartersnakes (*Thamnophis* spp.)). Recent surveys at CFB Suffield, however, did not document any occurrences of plains hognose snakes sharing hibernacula with other snake species (Wright 1998). It has been suggested that plains hognose snakes are sedentary and den most often within their summer range in sandy soils or in the burrows of fossorial mammals (Wright 1998). At CFB Suffield, the majority of plains hognose snake captures were further than 5 km from the

South Saskatchewan River, suggesting that the river valley does not represent prime overwintering habitat for this species (Wright 1998).

As plains hognose snakes have been frequently captured in Alberta in sandy areas where Northern pocket gophers are abundant, it has been speculated that the winter burrows of this rodent provide suitable hibernacula for the plains hognose snake (Wright 1998). As pocket gopher burrows extend below the line of frost-penetration, they offer suitable hibernacula sites, allowing the hognose snake to remain on its summer range year-round.

2.3.3 Breeding Habitat

Hognose snakes require suitable sandy or friable soil for egg laying. Eggs are usually laid in sandy soil at a depth of approximately 90 mm (Russell and Bauer 2000). More research is needed to study more specific breeding and egg laying habitat requirements of the hognose snake in Alberta.

2.3.4 Foraging Habitat

More research is needed to study the foraging behaviour and preferred foraging habitats of the hognose snake in Alberta. Native prairie areas with sandy surficial deposits, sufficient vegetation cover, and with seasonal or permanent wetlands that support important prey populations such as northern pocket gophers, Richardson's ground squirrels or great plains toads and plains spadefoot toads, are thought to provide preferred foraging habitats (Wright 1998).

2.3.5 Area Requirements

Home-range data is not available for plains hognose snakes in Alberta, however, this species is thought to have smaller home ranges than the prairie rattlesnake and bullsnake (Wright 1998). In Kansas, Platt (1969) reported that the longest mean distance traveled by snakes, recaptured after 31 to 50 days, was 200 m. Platt (1969) reported the shortest mean distance traveled was 89 m for snakes recaptured after more than 200 days. Male plains hognose snakes may shift their home range to seek a mate. Snakes may also shift their home ranges to better fulfill their nutritional or cover requirements (Wright 1998). In areas with a stable and sufficient prey base, snakes may travel very little during the active season (Wright 1998). For example, tagged snakes in Minnesota were repeatedly found outside the same burrows of either northern pocket gophers or thirteen-lined ground squirrels (Wright 1998).

3 PLAINS SPADEFOOT TOAD

3.1 <u>Background</u>

Plains spadefoot toads occur in the more arid regions of western North America, generally in association with ephemeral ponds and sandy soils (Cottonwood Consultants 1986, Klassen 1998, Lauzon 1999). The plains spadefoot occurs primarily in the southeast portion of Alberta (Lauzon 1999). Recent records indicate that its Alberta range extends as far north as Youngstown (Lauzon and Balagus 1998). According to a recent (2002) amphibian survey of the Milk River Basin, plains spadefoots were widely distributed across the basin, but were not found in the Milk River Ridge area or immediately south of the Cypress Hills (Taylor and Downey 2003). Plains spadefoots were detected at 192 out of 529 stops surveyed in the Milk River Basin and 253 breeding sites were present at these stops (Taylor and Downey 2003). In Canada, the range of this species extends east from Alberta into southern Saskatchewan and into the southwest corner of Manitoba (Lauzon 1999). In the United States it occurs south through the plains states to Chihuahua, Mexico and eastern Arizona (Russell and Bauer 2000). Although historical trend data is limited and more information is needed to accurately assess plains spadefoot populations in Alberta, their populations appear stable (Cottonwood Consultants 1986, Lauzon 1999). However, as spadefoot populations are sensitive to extended drought and habitat disturbance, this species is designated as "May Be At Risk" in Alberta at the general status level (SRD 2001a). At the national level, this species was designated as "not at risk" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in May 2003 (COSEWIC 2003).

Declines in amphibian populations world-wide have been attributed to a number of factors including traffic mortality, pollution (*e.g.,* fertilizers, pesticides, herbicides and acid precipitation), ionizing radiation (UV-B), exotic competitors, predators and pathogens (Canadian Amphibian and Reptile Network (CARCNET) 2002). The most important factor limiting the plains spadefoot appears to be the destruction and alteration of habitat (Lauzon 1999). Habitat loss or fragmentation has occurred due to extensive cultivation, urbanization, industrial development (*e.g.,* oil and gas exploration), road construction and wetland drainage (Lauzon 1999). Extensive herbicide and pesticide use and water management projects (*i.e.,* dams, reservoirs, or dugouts) are also considered threats to spadefoots, however, the impacts of these factors requires further study (Klassen 1998, Lauzon 1999).

3.2 Ecology

Plains spadefoot toads are active from late May until the fall, but are rarely seen outside of the breeding period (Russell and Bauer 2000). Spadefoots are well adapted to xeric conditions of deserts and prairies (Lauzon 1999). This species is nocturnal and spends the majority of its time underground, emerging only to breed during favourable conditions or to feed (Lauzon 1999). As their name implies, these toads use large, sharp, spade-shaped tubercles on their hind feet to help them burrow. Spadefoots burrow more deeply and emerge less frequently during periods of drought (Bragg 1965).

Spadefoots breed quickly during heavy rains and warm temperatures, and may breed more than once in a year if conditions are favourable (Lauzon 1999). Breeding may not occur at all during extended drought periods (Klassen 1998). In Alberta, breeding has been observed from early May to early July (Klassen 1998, Lauzon 1999). Females lay up to 2000 eggs in masses of 10 to 250 eggs (Bragg 1965, Collins 1982). Normal development of larvae requires water temperatures within limits of approximately 13 and 32 degrees Celsius (Blair *et al.* 1995). Under suitable conditions, spadefoot eggs hatch rapidly within about two days (Bragg 1965). In Alberta, tadpoles metamorphose 21 to 34 days after hatching, with some requiring up to 60 days (Klassen 1998).

3.2.1 Diet

Adult spadefoots are carnivorous, and prey on a variety of invertebrates, particularly nocturnal forms such as moths, ants and beetles (Whitaker *et al.* 1977, Russell and Bauer 2000). Spadefoot larvae feed on plankton and detritus (Russell and Bauer 2000).

3.2.2 Predators

Several snake species prey on adult plains spadefoots including garter snakes, bullsnakes and plains hognose snakes. Tadpoles may be preyed upon by aquatic arthropods (Russell and Bauer 2000).

3.3 Habitat Requirements

3.3.1 General

In Alberta, the plains spadefoot occurs primarily in the Grassland Natural Region where it has been observed in dry mixedgrass, mixedgrass and fescue prairie, sagebrush, sand dunes, and floodplains (Cottonwood Consultants 1986, Lauzon 1999). This species is generally found near temporary bodies of water and its distribution is strongly correlated with sandy or friable soils suitable for burrowing (Lauzon 1999, Russell and Bauer 2000). Adults rest in rodent burrows or self-constructed burrows in sand or other easily penetrated soil (Lauzon 1999).

The broad-scale habitat suitability index model (HSI) for plains spadefoot toads in the Milk River Basin incorporated two equally weighted variables: soil texture and native prairie class (NPC) (Taylor 2004a). According to this model, Class 1 native prairie habitats with moderately coarse and coarse soil textures represent preferable spadefoot habitat. Class 1 native prairie is comprised of more than 75% native prairie components. Moderately coarse and coarse textured soils include sandy loam, sands and loamy sands.

3.3.2 Hibernacula

To avoid freezing and desiccation during the winter, plains spadefoots burrow deeply into sandy soils, usually to depths below the frost line (Lauzon 1999). These toads are known to burrow up to 1 m deep in order to find a damp hibernation site (Russell and Bauer 2000). Plains spadefoots are also capable of super-cooling to -4.3^{o}C which helps them to avoid freezing in shallower burrows over the winter (Swanson and Graves 1995).

3.3.3 Breeding Habitat

Breeding opportunities are dependant on the availability of sites including temporary pools or flooded areas that vary from several centimeters to more than one meter, often with a mud bottom and either with clear or turbid water (Blair *et al.* 1995). Cottonwood Consultants (1986, p.15) reported that spadefoots breed in “shallow water of vernal pools on uplands and along streams, semi-permanent ponds, oxbow lakes and stream meander channels”. Eggs are usually deposited in areas of still, shallow water (Krupa 1994). To ensure survival, water needs to persist until larvae metamorphose.

Taylor and Downey (2003) reported that general conditions of spadefoot toad breeding sites in the Milk River Basin were ephemeral ponds less than 50 cm deep with little to no aquatic vegetation (Taylor and Downey 2003). Klassen (1998) reported that spadefoot toads in the Milk River area bred in sloughs with little vegetation, marshy depressions, flooded cultivated fields, temporary wetlands in pastures, small pools, river backwaters and ditches. Although spadefoots appear to be opportunistic in their selection of breeding ponds, Taylor and Downey (2003) observed that the only sites that allowed complete development of tadpoles were ephemeral ponds within native prairie. Ditches and sites near cultivation often fail to retain sufficient water to allow for completion of metamorphosis (Taylor and Downey 2003). Breeding ponds located in native prairie grasslands in the Milk River Basin occurred in areas dominated by blue grama (*Bouteloua gracilis*), june grass (*Koeleria macrantha*), needle-and-thread, and northern wheatgrass (*Agropyron dasystachyum*) (Klassen 1998).

3.3.4 Foraging Habitat

Little is known about the preferred foraging habitats of plains spadefoots in Alberta. Spadefoot larvae feed in still, shallow water in flooded areas and temporary often mud-bottomed pools (Lauzon 1999). Adult spadefoots feed aboveground during the night, usually in humid or rainy weather, likely in the vicinity of suitable burrowing habitat.

3.3.5 Area Requirements

More research is needed to determine the summer movements and home range size of plains spadefoot toads (Lauzon 1999). Spadefoots are capable of migrating at least 1.6 km to breeding sites (Landreth and Christensen 1971). In Alberta, Klassen (1998) recorded juvenile plains spadefoots more than 2 km from known breeding wetlands, however, these toads may have originated from unknown sites.

4 GREAT PLAINS TOAD

4.1 <u>Background</u>

Great plains toads, like plains spadefoot and hognose snakes are restricted to the southeast corner of Alberta and are at the northern extreme of their range in the province (James 1998, Russell and Bauer 2000). These toads are considered to have a rare and localized distribution in Alberta (Cottonwood Consultants 1986). Their general range in the province extends from the Red Deer River south to the Montana border, and east from Taber to the Saskatchewan border (James 1998). Six general population areas have been documented in Alberta at the following locations: Empress / Bindloss; South Saskatchewan River/ Hilda; Medicine Hat; Lost River / Milk River; Lake Newell / Little Rolling Hills; and Hays / Purple Springs (Wershler and Smith 1992). Additional populations have been documented in and around CFB, Suffield (Didiuk 1999). Great plains toads were observed at 19 out of 529 stops surveyed during a recent (2002) roadside amphibian survey of the Milk River Basin (Taylor and Downey 2003). At the 19 sites, 21 breeding sites were present, all of which were located east of Lost River (Taylor and Downey 2003). Great plains toads also occur in southern Saskatchewan and the extreme southwestern corner of Manitoba (James 1998). A paucity of information is available regarding the historic range of this species in Canada (James 1998). In its greater range, great plains toads are widely distributed in western North America and the northern half of Mexico (Diduik 1999).

As with spadefoot toads and plains hognose snakes, there is limited long-term monitoring data for great plains toads, making it difficult to assess their population status (James 1998). Great plains toad population numbers are thought to fluctuate widely over time given their reliance on rainfall for reproduction (James 1998). Due to their rarity and apparent declines in their population as well as loss of critical breeding habitat, great plains toads are listed as "May Be At Risk" of extirpation in Alberta at the general status level (SRD 2001a). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated this species as one of "Special Concern" in April of 1999 (COSEWIC 2002). This status was reconfirmed in May of 2002 (COSEWIC 2002).

Great plains toads are thought to be limited by the quality and availability of suitable breeding sites in Alberta (James 1998). Habitat alteration and destruction (*i.e.,* wetland loss or alteration), hydrological changes, pollution (*e.g.,* pesticide and herbicide use), road kills and oil and gas exploration and development are considered the main anthropological factors that threaten the long-term survival of this species in Alberta (Cottonwood Consultants 1986, Wershler and Smith 1992, James 1998, Diduik 1999). Drought and to a lesser extent, predation, are considered to be primary natural limiting factors (Wershler and Smith 1992, James 1998).

4.2 Ecology

Like plains spadefoot toads, great plains toads are opportunistic spring breeders and in dry years will only breed following large precipitation events (Krupa 1994). Great plains toads may not attempt to breed during years with prolonged drought (James 1998). In Alberta, great plains toads usually breed from late April to mid- June (Cottonwood Consultants 1986, Didiuk 1999). Toads often form large breeding assemblages and lay their eggs in a communal mass, often in the same location each year (Krupa 1994, James 1998). Females produce approximately 1,300 to 45,000 eggs, with a documented average clutch size of approximately 9,400 eggs (Krupa 1994). Larger females will lay more eggs than smaller females. Great plains toads are capable of laying multiple clutches. Eggs will hatch in 1 to 5 days depending on ambient temperature (Krupa 1994). Tadpole metamorphosis can range from 18 to 49 days and is also temperature dependent (Krupa 1994). Desiccation of breeding pools prior to completion of metamorphosis can lead to a high rate of tadpole mortality (Krupa 1994). Newly metamorphosed young have been reported in Alberta as early as June 28 and July 18 (Wershler and Smith 1992). New toads will stay in their natal pond area for a month or until it desiccates (Smith and Bragg 1949). Toads attain sexual maturity in 3 to 5 years (Russell and Bauer 2000).

Great plains toads have numerous adaptations to enable them to survive in arid grasslands. One of their primary means of coping with wide temperature fluctuations and prolonged drought is their ability to burrow underground for lengthy periods (James 1998, Russell and Bauer 2000). Great plains toads are also mostly nocturnal, foraging mainly at night or during the day during wet periods (James 1998). Large quantities of food are consumed during favourable periods, allowing this toad to burrow and remain dormant during hot, dry weather (Bragg and Smith 1943, James 1998). As these toads may live as long as two decades, their longevity has been suggested as another survival adaptation (James 1998). Their long lifespan enables them to wait out prolonged dry periods between successful breeding events (James 1998).

4.2.1 Diet

Great plains toads are thought to be opportunistic feeders, as diet composition is determined principally by availability rather than selection (Smith and Bragg 1949). Common prey include ground-dwelling, nocturnal insects such as beetles, ants and spiders (Smith and Bragg 1949) Tadpoles feed mainly on algae and decomposing vegetation or invertebrates (Bragg 1940).

4.2.2 Predators

Plains hognose snakes and corvids (such as crows) are listed as great-plains toad predators in Alberta (Wershler and Smith 1992, James 1998). Tadpoles commonly fall prey to birds, insect larvae and spadefoot tadpoles (James 1998).

4.3 Habitat Requirements

4.3.1 General

Great plains toads inhabit the sand plain and sandhill habitat types within the Dry Mixedgrass and Mixedgrass Natural Subregions of southeastern Alberta (James 1998). This toad typically avoids woodlands and the floodplains of streams (Bragg 1940).

Three variables were included in the habitat suitability index (HSI) model for the great plains toad in the Milk River Basin: Native Prairie Class, soil order and soil texture (Taylor 2004b). According to this model, Class 1 native prairie areas with chernozemic / solonetzic soil orders and with moderately coarse (sandy loam) and coarse (sand and loamy sand) textured soils provide optimal habitat for great plains toads. Class 1 native prairie areas are comprised of greater than 75% native prairie components. Chernozemic / Solonetzic soil orders are thought to be preferred as their poor drainage characteristics accommodate the formation of ephemeral ponds that last long enough to accommodate breeding. Coarse textured soils are preferred as they provide suitable burrowing habitat.

4.3.2 Hibernacula

Although undocumented, it is thought that great plains toads burrow deeply into sandy soils to avoid freezing over the winter (James 1998). Fossorial mammal burrows may provide suitable overwintering habitat for this species (Didiuk pers. comm.). A similar species, the Canadian toad (*Bufo hemiophyrus*) is known to hibernate in “mima-type” mounds that are thought to be the result of pocket gopher activity (Breckenridge and Tester 1961). Canadian toads hibernate on the upland within approximately 23 m to 115 m from breeding pond margins (Breckenridge and Tester 1961).

4.3.3 Breeding Habitat

In Alberta, great plains toads breed mostly in seasonal (ephemeral) waterbodies such as potholes or prairie depressions that are filled with water during spring runoff and early season rains (Wershler and Smith 1992). Some permanent and semi-permanent wetlands may also be used such as springs, irrigation projects and dikes in shallow drainages (Wershler and Smith 1992). More permanent waterbodies or those located in irrigated areas provide stable breeding sites during long periods of drought (Wershler and Smith 1992). However, great plains toad tadpoles may have a greater chance of survival in temporary rather than permanent wetlands as studies have found that permanent ponds harbour a greater abundance of aquatic and terrestrial predators (Woodward 1983). Water clarity is thought to be an important characteristic of breeding sites, as toads reportedly will not breed in muddy or turbid waters (Bragg 1940, Bragg and Smith 1943, James 1998). Wershler and Smith (1992, p.3) described the typical breeding habitat of great plains toads in Alberta as "shallow ponds with relatively fresh, clear water in areas of sandy soil". All ponds surveyed during 1987 to 1990 in Alberta were located in native prairie areas, and no ponds occupied by great plains toads were found in cultivated areas (Wershler and Smith 1992). Wershler and Smith (1992) found that tall emergent vegetation (*e.g.,* cattails and bulrushes) was uncommon in breeding ponds, whereas submerged vegetation (*e.g.,* pond weeds such as *Potamgeton* spp.) was abundant in some ponds in non-irrigated areas. In irrigated areas, algal growth in breeding ponds was used as calling perches by males and was thought to provide egg attachment sites and shelter for tadpoles (Wershler and Smith 1992).

At CFB Suffield, Didiuk (1999) reported that great plains toads occurred most often in larger seasonal basins in high relief morainal deposits, commonly in association with plains spadefoot toads.

4.3.4 Foraging Habitat

More research is needed to determine the preferred foraging habitat of great plains toads in Alberta. Young toads tend to remain near breeding ponds until these ponds evaporate. As toads mature they become nocturnal and will forage in grassland areas during the night within range of suitable sandy, burrowing soils (Smith and Bragg 1949). In Oklahoma, great plains toads have been found to burrow and feed in cultivated fields with suitably friable soils (Smith and Bragg 1949).

4.3.5 Area Requirements

The home range size and seasonal movements of great plains toads have not been well studied in Alberta. Incidental observations from pitfall snake traps used at CFB Suffield, suggest that adult toads may move approximately 1 km from known breeding ponds (Didiuk pers. comm.).

5 GRAZING AND HOGNOSE SNAKES, SPADEFOOT TOADS AND GREAT PLAINS TOADS

Livestock grazing is the dominant land use in southeastern Alberta where hognose snakes, plains spadefoot toads and great plains toads occur. The direct and indirect effects of grazing on these species have not been well studied in Alberta or in their greater North American range. Additional research is also needed to characterize the habitat requirements and biology of these species in Alberta to better understand the potential impacts of grazing. Since ranching allows for the retention of intact native prairie areas and critical wetlands, and as most native prairie fauna coexisted in their historical range with bison, livestock grazing is generally considered a beneficial land use for maintaining habitat for a diversity of wildlife species. However, the benefits of livestock grazing depend on appropriateness of stocking rates, timing of grazing use, and distribution of cattle in relation to critical habitats.

Directly, intensive livestock use near wetlands can have a negative impact on the survival of amphibian larvae due to trampling or increased water turbidity and creation of anoxic conditions from nutrient loading, erosion and defecation (Didiuk 1999, Didiuk pers. comm.). Trampling mortality, soil compaction or the removal of thermal or escape cover are other potential negative effects from livestock grazing on herpetofauna. The creation of dugouts in ephemeral wetland basins can also have negative effects on great plains toad and spadefoot toad breeding sites (James 1998, Didiuk pers. comm.). Dugouts created within wetland basins drain water from potentially suitable toad breeding sites (Didiuk pers. comm.). High sided, deep dugouts with no emergent vegetation cover do not provide suitable breeding habitats for spadefoot or great plains toads (James 1998, Didiuk pers. comm.). Great plains toads call from tall emergent vegetation (grasses or sedges) and both spadefoot and great plains toads require emergent vegetation and shallow, warm water to provide suitable sites for egg mass attachment and rapid egg and larval development (James 1998, Lauzon 1999). Submerged vegetation also provides important shelter for developing tadpoles.

Positive effects may occur from livestock use if trampling or grazing creates basking sites or breaks up dense sod creating suitable burrowing sites for snakes and toads (Denton and Beebee 1996). Livestock “wallowing” can also create depressions which form into suitable breeding sites (ephemeral wetlands) for toads following rainfall (Bragg 1940). Bragg (1940) noted that great plains toads in Oklahoma bred primarily in rain-formed pools in “buffalo wallows” in uncultivated areas.

Indirectly, livestock herbivory affects plant species composition and vegetation structure, which may influence the community composition or abundance of small mammal or insect prey. A diverse small mammal population not only provides a prey source for hognose snakes, but also increases the availability of burrow shelters for snakes and toads (Breckenridge and Tester 1961, Wright 1998, Didiuk 1999). Uniform, heavy grazing for prolonged periods has been found to depress populations of most small mammals (Fagerstone and Ramey 1996). Light to moderate grazing intensity, in contrast, stimulates diversity in the vegetation canopy and consequently creates habitat for a greater variety of small mammals. Light to moderate grazing promotes diverse vegetation structure by creating a gradient of heavy, moderate to lighter use patches across the landscape.

The following discussion summarizes the potential interactions of grazing on plains hognose snakes, spadefoot toads and great plains toads based on available studies and discussions with species experts.

5.1 Plains Hognose Snake Response to Grazing

According to information from captures at CFB Suffield, plains hognose snakes were found in highest densities in open, sandy plains, where grazing pressure was described as “light”, resulting in a “heavy cover of mixed grasses”; and secondly in “open plains with light to moderate grazing pressure near wetlands” (Wright 1998, p.2). Lesser densities of snakes were found in the following habitats: sandhill country; short or mixedgrass plains with a heavy sod layer and “moderate to heavy” grazing pressure and gravelly, glacial till-plains; and riparian areas (Wright 1998, p.2). These results suggest that appropriate management of stocking rates (*i.e.,* light to moderate grazing) may be important for maintaining suitable hognose snake habitat. Managing the impact of grazing near seasonal or permanent wetlands is also considered important (Didiuk 1999). Seasonal wetlands with clear, clean water provide critical breeding sites for great plains toads, an important hognose snake prey item (Wright 1998).

Hognose snakes at CFB Suffield were also found most frequently in association with northern pocket gophers. Pocket gophers are generally attracted to rangeland in good to excellent condition that have vigorous plants with large root systems (Fagerstone and Ramey 1996).

5.2 Plains Spadefoot Toad Response to Grazing

Plains spadefoots have been observed to successfully reproduce in ponds that were heavily disturbed by cattle in the Milk River area (Klassen 1998). However, breeding success has not been compared between disturbed and undisturbed breeding sites. Soil compaction by cattle in the vicinity of breeding sites may reduce the availability of suitable burrowing sites (Didiuk pers. comm.). Heavy use near breeding sites can also reduce vegetation cover, diminishing predator escape cover or foraging opportunities for young toads (Didiuk pers. comm.).

5.3 Great Plains Toad Response to Grazing

As water clarity is considered an important characteristic of great plains toad breeding sites, heavy cattle trampling and use near breeding ponds may be detrimental to the reproductive success of this species (Bragg and Smith 1943, Wershler and Smith 1992). Heavy trampling, erosion and cattle defecation near breeding sites has the potential to reduce water quality and vegetation cover at these sites. Deep hoof prints and hummocking along wetland edges may also entrap or make it difficult for toads to access or exit ponds (James 1998). Yet, Bragg (1940) noted that great plains toad tadpoles have fully developed in waters that were disturbed by livestock after egg laying and hatching. Newly transformed young may face trampling risks from heavy use near breeding ponds as young toads often remain near pools until they evaporate (Smith and Bragg 1949).

6 GRAZING SYSTEMS AND HOGNOSE SNAKE, SPADEFOOT TOAD AND GREAT PLAINS TOAD HABITAT MANAGEMENT

Table III-12 provides an overview of six grazing systems and their potential implications for maintaining or enhancing habitat for hognose snakes, spadefoot toads and great plains toads. A grazing system is a tool used to control the timing, intensity and frequency of livestock grazing (Holechek *et al.* 2003).

Table III-12 Grazing Systems and Hognose Snake, Spadefoot Toad and Great Plains Toad Habitat Management

Grazing System	Discussion
Continuous (Season-Long) Grazing	
Advantages:	As livestock densities are typically lower in continuous grazing systems there is less risk of soil compaction (Abouguendia and Dill 1993). Soil compaction impedes the ability of hognose snakes and toads to burrow into the ground for shelter in areas of sandy soil overlain by finer textured soils. Under light to moderate stocking rates, continuous grazing often results in heterogeneous vegetation structure due to patchy grazing. Patches of unused or lightly grazed, taller vegetation provide shade and predator escape shelter for snakes and toads. More heavily grazed sites provide basking sites and may break up dense sod and create burrowing sites (Denton and Beebee 1996). More heavily used areas would also maintain active sand dunes or areas with bare sand, perhaps increasing suitable burrowing sites for toads and snakes. Structural diversity also favours a greater number of rodent species, potentially providing a more stable and varied prey base for snakes (Fagerstone and Ramey 1996). The benefits of continuous grazing depend on maintaining sustainable stocking rates and the effectiveness of livestock distribution tactics (*i.e.,* salt, herding or water developments) to distribute cattle away from critical toad breeding sites, particularly during the breeding season.
Disadvantages:	Continuous grazing can be particularly damaging to riparian areas (including wetlands, streams and rivers), as livestock will congregate and linger near water throughout the duration of the grazing season from spring to fall (Ohmart 1996, Fitch and Adams 1998, Holechek *et al.* 2003). For this reason, continuous grazing nearly always results in overuse of riparian areas (Ohmart 1996). Heavy, persistent grazing in riparian areas can result in trampling and removal of vegetative cover, increased erosion and degraded water quality. These factors have the potential to negatively effect habitat quality and reproductive success of spadefoot and great plains toads. At heavy stocking rates, continuous use of fragile sandy soil range sites can lead to accelerated erosion of these rangelands, potentially diminishing the long-term productivity of these sites for vegetation growth and sustainable livestock production (Houston pers. comm.). Hognose snakes have been found in lesser densities in moderate to heavily grazed short or mixedgrass plains in southern Alberta (Wright 1998).

Grazing System	Discussion
Deferred Grazing	
Advantages:	Deferred spring grazing has the advantage of preventing cattle use near wetlands used for breeding by great plains and spadefoot toads during the breeding season (late April to mid- July). This minimizes possible negative effects due to trampling of egg masses or newly developed toads and reduced water quality from erosion or defecation (Didiuk pers. comm.). A study conducted in southern Alberta found that a deferred-grazed native grassland associated with a wetland creation project supported a greater number of herptiles (amphibians and reptiles) than seeded and continuously-grazed native pastures (Fisher and Roberts 1994). The deferred-grazed native pasture supported various species including boreal chorus frogs, tiger salamanders, plains garter snakes and plains spadefoot toads (Fisher and Roberts 1994).
Complementary Grazing	
Advantages:	Using seeded pasture in the spring allows for deferred use of native prairie during the critical breeding season (see above). Herbicide and pesticide should not be applied to seeded pastures near breeding sites or foraging habitats used by toads and snakes. To retain adequate cover and minimize disturbance to the hydrology of breeding wetland sites, a minimum, 15 meter unseeded buffer should be retained around wetlands contained within seeded pastures (Kingsbury and Gibson 2002).
Disadvantages:	Complementary grazing requires the use of seeded pasture, which may not be available in all livestock operations. Seeded pasture is often not suitable in many places in the mixedgrass and dry mixedgrass prairie due to fragility of soils and dry conditions. Seeded pastures are considered lesser quality habitat for hognose snakes, spadefoot toads and great plains toads (Cottonwood Consultants 1986). Fisher and Roberts (1994) reported that seeded pastures that formed part of the Medicine Wheel Project in southern Alberta, supported significantly fewer herptiles than deferred-grazed native pastures.
Rotational Grazing	
Advantages:	Kingsbury and Gibson (2002) recommend light to moderate rotational grazing, with no more than one third of available habitat grazed in one year, as an effective means to manage habitat for a diverse population of amphibians and reptiles. Rotational grazing systems are often recommended as a means to improve the health of riparian areas as it promotes periods of rest and recovery. Rotational grazing may therefore benefit the quality of toad breeding sites. This type of grazing system also offers a means to control the timing of grazing in critical habitats to avoid sensitive periods. This includes avoiding use near hognose snake hibernacula in the spring and fall and avoiding use near toad breeding areas in the spring and summer (late April to mid-July). Periods of rest and recovery are also beneficial for maintaining the long-term productivity and stability of sandy soil range sites, while allowing for periodic disturbance to maintain some areas of active sand dune sites.
Disadvantages:	Under heavy stocking rates, rotational grazing can lead to uniform grazing effects, diminishing vegetation structural heterogeneity. A uniform reduction in vegetation cover diminishes available thermal cover and shelter sites for snakes and toads and can reduce the suitability of an area for populations of some small mammals such as voles and pocket gophers (Fagerstone and Ramey 1996).

Grazing System	**Discussion**
Intensive Grazing	
Advantages:	Intensive, short periods of grazing in the fall may be beneficial for reducing encroachment of tall exotic grasses such as smooth brome (*Bromus inermis*) or timothy (*Phleum pratense*) in hognose snake or toad foraging areas or dispersal corridors. Intensive grazing in the spring may have a similar effect but may jeopardize the health and productivity of breeding wetlands.
Disadvantages:	Sandy soil range sites may be subject to greater risks of erosion and destabilization of vegetation when managed under intensive grazing systems (Houston pers. comm.). Intensive grazing also has the potential to increase soil compaction and create uniform vegetation structure across the range, diminishing burrowing opportunities for hognose snakes and toads and reducing thermal and escape cover. Intensive grazing systems can also result in degradation of riparian areas, possibly diminishing the quality of toad breeding sites and increasing trampling risks to egg masses, tadpoles and newly transformed young. The impacts of intensive grazing depend on the timing of grazing use in paddocks that contain breeding sites, and on the period of rest following grazing.
Riparian Area Grazing	
Advantages:	Grazing systems designed to improve the health of wetland riparian areas may benefit spadefoot and great plains toads by: i) reducing grazing impact to breeding sites during the breeding period; and / or ii) resulting in improved water quality and vegetation cover at and around breeding sites.
Disadvantages:	Given the ephemeral nature of wetlands used as breeding sites by spadefoot and great plains toads, it may be difficult to develop grazing management plans for these types of seasonally variable riparian areas.

7 BENEFICIAL MANAGEMENT PRACTICE RECOMMENDATIONS

Sandhill and sand plain areas with ephemeral wetland basins in the Milk River Basin are considered prime habitat for plains hognose snakes, spadefoot toads and great plains toads (Cottonwood Consultants 1986). Conservation and proper management of native prairie habitat and wetlands in these areas is, therefore, important to the long term survival of these species. Sandhill and sand plain habitats are often considered fragile ecosystems that are especially susceptible to damage from overuse by livestock, human activities or industrial development (Cottonwood Consultants 1986).

The following general land use and grazing recommendations offer a variety of means to protect or maintain plains hognose snakes, spadefoot toads and great plains toads populations and their habitat within the Milk River Basin. These recommendations apply to the full-extent of their range within the Grassland Natural Region of Alberta. Further research (Section 8) is required to gain a better understanding of the ecology, habitat use and population dynamics of these herptiles, as well as to better understand the influence grazing has on these species, their habitats and their primary prey.

7.1 General Recommendations

Native Prairie Conservation

- Protect remaining mixedgrass and dry mixedgrass native prairie and sand plain and sandhill areas in the Milk River Basin from cultivation or development. Hognose snakes, plains spadefoot and great plains toads are all primarily associated with native prairie habitats. These species either do not occur or are found less frequently in cultivated areas (Cottonwood Consultants 1986). Cultivation is thought to render an area largely or entirely unsuitable for these species due to removal of cover, destruction of wetlands, soil compaction and associated risks from machinery and chemical use (Wright 1998, Russel and Bauer 2000). Cultivation can also reduce or locally eliminate colonial small mammal populations and their burrows, which are an important source of shelter and or food for hognose snakes, spadefoot toads and great plains toads. Tall and dense cropland or seeded pasture vegetation may also render areas unsuitable to snakes and amphibians by impeding their movement and dispersal across the landscape.
- Maintain or reestablish natural corridors between suitable native prairie habitat patches (Kingsbury and Gibson 2002). Retain uncultivated areas such as ditches or rights-of-way adjacent to existing cultivated areas to create dispersal corridors for hognose snakes and support rodent prey (Wright 1998).

Wetland Restoration or Conservation

- Restore formerly drained wetlands in plains hognose snake, spadefoot and great plains toad habitats and prevent further wetlands from being drained or cultivated. Ephemeral wetlands cultivated during dry years have less ability to hold water in wet years (Taylor and Downey 2003). Ephemeral or seasonal wetlands provide critical breeding habitat for spadefoot and great plains toads. Great plains toads are known to congregate in large masses and use the same breeding sites in successive years (Krupa 1994).

- Avoid converting ephemeral breeding wetlands into permanent water bodies (Lauzon 1999). Permanent water bodies may harbour a greater abundance of aquatic and terrestrial predators than seasonal wetlands and are considered lower quality breeding sites for spadefoot and great plains toads (Woodward 1983). Altering wetlands may also affect water quality, vegetation composition, gradient and other factors that may influence their suitability as toad breeding sites.
- Maintain natural water levels and fluctuations (*i.e.,* avoid altering the natural hydrology of toad breeding sites) (Kingsbury and Gibson 2002).
- Identify and catalogue or map ephemeral wetlands that provide potential breeding habitat for plains spadefoot and great plains toads.
- Protect a buffer of native vegetation around identified wetlands. Kingsbury and Gibson (2002) recommend leaving a minimum buffer of 50 feet (15 m). Maintaining a vegetated buffer around wetlands alleviates erosion and improves water quality by filtering out sediment and contaminant loads from runoff (Kingsbury and Gibson 2002). Vegetation cover around wetlands also provides cover and foraging habitat for hognose snakes and toads (Wright 1998).
- Maintain or reestablish natural corridors or native prairie patches between ephemeral wetlands used for breeding (Kingsbury and Gibson 2002). Isolated wetlands or wetlands fragmented by unsuitable habitat can isolate amphibian populations and cause small populations to die out.
- Avoid the introduction of game fish into natural wetlands used as toad breeding ponds (Kingsbury and Gibson 2002). Fish are efficient predators of amphibian eggs and larvae and can have a severe impact on amphibian reproductive success (Kingsbury and Gibson 2002).

Pest Control

- Avoid the use of pesticides or herbicides in marginal agricultural areas near plains hognose snake, spadefoot and great plains toad habitats (James 1998, Wright 1998, Lauzon 1999). Chemical and sediment runoff from agricultural areas into wetland basins used for breeding degrades water quality and may adversely affect the breeding success or health of amphibians and the species that prey on them (*i.e.*, hognose snakes) (Kingsbury and Gibson 2002). Agricultural pesticides and herbicides have been found to have adverse effects on various amphibian species in Canada, including resulting in mutation, death or paralysis of tadpoles (Berill *et al.* 1997, Bonin *et al.* 1997). Amphibians are especially susceptible to harmful pollutants as they breathe through their skin. Pesticide use may also reduce the availability of insect or rodent prey for toads and hognose snakes (Anderson *et al.* 1999).
- Promote organic farming practices. Organic farming practices promote natural alternatives to synthetic pesticides or fertilizers. Organic farming thereby discourages the use of harsh chemicals that could poison or diminish food supplies for hognose snakes, plains spadefoot and great plains toads.
- Discourage the use of poisoning programs to control high densities of Richardson's ground squirrels or northern pocket gophers. Ground squirrels and pocket gophers are considered potentially important prey items for hognose snakes (Wright 1998), and their burrows

provide refugia and potential hibernacula for hognose snakes, spadefoot and great plains toads (Breckenridge and Tester 1961, Wright 1998, Didiuk 1999).

- Promote snakes and other natural predators as biological, 'pest' control agents.

Critical habitat protection and industrial development mitigation

- Abide by setback distances and timing restrictions recommended by SRD, Fish and Wildlife Division for human activities, including industrial development near to hognose snake hibernaculae (SRD 2001b). SRD recommends a 200 m year-round setback for wellsites, powerlines, pipelines or roads from hognose snake hibernaculae.
- Abide by SRD, Fish and Wildlife Division setback distances from great plains toad and plains spadefoot toad ponds "used for living, breeding or hibernating" (SRD 2001b, p.4). SRD recommends a 100 m year-round setback for wellsites, powerlines, pipelines or roads from toad ponds. Aside from direct destruction of breeding ponds, oil and gas development may also affect toads due to disruption of groundwater resources, ground and surface water contamination, and the consumptive use of water for drilling (Wershler and Smith 1992).
- Where possible, avoid construction during the sensitive spring breeding season (late April to mid-June) to reduce possible impacts to hognose snakes, toads and other wildlife (Lauzon 1999).
- In areas where hognose snakes, spadefoot and great plains toads are known to occur, routinely check and remove snakes and toads from pipeline trenches during construction (Wright 1998). Didiuk (1999) reported several instances of hognose snakes and more commonly, great plains toads trapped at the bottom of underground "caissons" (structures that contain equipment and gas piping) at CFB, Suffield.
- Known hibernacula sites in Alberta are listed in the provincial Biodiversity / Species Observation Database (BSOD). Developers should conduct queries of this database as part of their environmental planning for proposed developments.
- Conduct pre-development wildlife surveys for hognose snakes, spadefoot and great plains toads where suitable habitat for these species exists.
- The Milk River Basin geographic information system (GIS) HSI maps that were developed for plains spadefoot and great plains toads should be used to inform environmental planning of oil and gas activities and other developments to ensure that areas with high potential for critical habitats are avoided. Once additional information is available, an HSI model should be developed for plains hognose snakes.

Road Mortality

- A provincial road-kill monitoring program has been initiated in Alberta for all snake species to show problem areas for snake mortality and to provide distribution information for various species (Alberta Endangered Species Conservation Committee (ESCC) 2000). This program should be expanded to include amphibians.
- In areas with high densities of hognose snakes in proximity to roads, appropriate speed limits and warning signs should be posted to notify vehicles to use caution. Roads and associated

mortality due to vehicle collisions are considered the second most limiting factor to hognose snakes in Alberta (Wright 1998).

- Road kills are considered a significant cause of mortality for adult and juvenile spadefoot and great plains toads in the central part of their range in the United States (Bragg 1940, Smith and Bragg 1949, James 1998). The impact of road mortality on these species in Alberta requires further study. Where possible, traffic should be minimized on roads near critical toad breeding areas in the spring (from May to June), particularly during or following periods of rain.

Public Awareness

- Plains hognose snakes are occasionally killed as a result of being mistaken for the prairie rattlesnake (Wright 1998). Public awareness campaigns are helpful for reducing this type of problem as well as promoting the plight of rattlesnakes, another species listed as "May Be At Risk" of extirpation in the Milk River Basin (SRD 2001a).
- Poster campaigns, distribution of pamphlets and tapes, and other public information initiatives are useful for encouraging public support in monitoring and documenting new records of rare amphibians and reptiles in Alberta. Volunteer support is considered especially important to the long-term success and effectiveness of the *Alberta Amphibian Monitoring Program* and the *Bird Studies Canada Marsh Monitoring Program* (Takats and Priestley 2002, Priestley 2002). Both of these monitoring initiatives aim to provide long-term information about amphibian populations, distribution, and habitat use in Alberta.

7.2 Grazing Recommendations

Livestock grazing systems that will benefit plains hognose snakes, plains spadefoot and great plains toads should aim to:

- minimize impact to critical breeding wetlands during the spring breeding season (late April to mid-July);
- provide a variable grassland structure to provide amphibians and reptiles and their prey with a diverse range of microsites, ranging from more open sites for basking to more shaded, moist sites with adequate cover;
- retain adequate vegetation cover in and around critical breeding wetlands; and
- minimize soil compaction near overwintering, breeding and foraging sites.

Ultimately, the selection of an appropriate grazing system will depend on local ecological conditions, distribution of key habitat components and range management goals. Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

The following recommendations consider grazing management practices that will likely benefit hognose snakes, plains spadefoot and great plains toads, and also maintain the condition of mixedgrass or dry mixedgrass prairie associated with sandy range sites.

- Use low to moderate stocking rates in pastures that contain or connect critical spadefoot toad, great plains toad and hognose snake breeding, foraging and overwintering habitats (Wright 1998, Didiuk 1999, Kingsbury and Gibson 2002). Adjust stocking rates during drought conditions.
- Maintain utilization rates of 50% for mixedgrass and dry mixedgrass prairie to ensure adequate carry-over of residual vegetation and litter (Adams *et al.* 1994). This will help to prevent uniform grazing effects and retain sufficient upland cover for toads dispersing overland. Sufficient cover offers shelter from predators and helps to prevent desiccation of toads. Vegetation cover is also considered important for northern pocket gophers, an important hognose snake prey.
- Use once over grazing per season when implementing grazing systems in sandy range sites (Houston pers. comm.).
- Place salt or mineral sources at least 1 km from natural water bodies, where possible (Adams *et al.* 1986). Placing salt away from water forces cattle to make better use of the range and reduces the amount of time cattle spend at critical breeding wetlands.
- Provide alternate watering sites (*i.e.,* dugouts or troughs) to reduce impact to great plains toads breeding wetlands. Cattle have been shown to prefer drinking from a water trough and will travel further to a trough rather than drink from a stream when given free access to both (Veira 2003). Off-site watering can provide a more reliable and cleaner water source for cattle. Improved water quality can improve livestock health and weight gain (Veira 2003).
- Avoid the creation of dugouts in critical toad ephemeral breeding ponds (James 1998, Didiuk pers. comm.). Dugouts are not considered suitable breeding habitats for great plains toads or spadefoots due to their depth, steep sides, lack of vegetation, nutrient loading and heavy use by cattle (James 1998, Didiuk pers. comm.). Didiuk (1999) noted that great plains toads at CFB Suffield only bred in dugouts located in depressions with flooded areas immediately adjacent to the dugout.
- Modify existing dugouts to create a low shoreline gradient with shallow, marshy edges to improve habitat available to great plains toads (James 1998, Didiuk pers. comm.).
- Defer use near plains spadefoot and great plains toad breeding ponds during the spring breeding season (late April to mid-July) to reduce impact to water quality, retain vegetation cover, and prevent possible trampling mortality to spawning adults, egg masses, tadpoles or newly developed toads.
- Where necessary, fence out important great plains toad breeding ponds to restore water quality or vegetation cover or to prevent damage during the breeding season.
- Use rest- or deferred once-over rotation grazing systems to improve native prairie and riparian area health as well as to defer livestock use during the breeding season (Fisher and Roberts 1994).

8 RESEARCH RECOMMENDATIONS

As the herpetofauna considered in this report are rare and have not been extensively studied in Alberta, more information is needed to characterize their habitat requirements, movement patterns and population dynamics in the Milk River Basin using radio-telemetry and mark-recapture studies (Didiuk pers. comm.). This type of research will help in understanding how various land use activities such as livestock grazing influence these species. Developing a regular monitoring program that encompasses a variety of habitat types and moisture regimes is an important first step in building a better understanding of the population status, trends and distribution of hognose snakes, plains spadefoot and great plains toads.

The goal of grazing management research should be to assess exactly how much of an impact livestock grazing is having on critical amphibian and reptile habitat components (including hibernacula, breeding sites, burrowing sites, thermoregulation cover and foraging habitat), and to determine which grazing strategies (*i.e.,* timing, distribution, stocking rates) are most beneficial or are most effective at mitigating negative impacts.

Key research needs are described below for each species

8.1 Plains Hognose Snake

- Develop a hognose snake monitoring program for the Milk River Basin to assess fluctuations in snake populations and ranges.
- Conduct additional research to study the basic biology, ecology and habitat use by plains hognose snakes in Alberta. Research should focus on learning more about the preferred habitat and range of this species in Alberta and providing data on various undetermined aspects of this species' biology (Wright 1998).
- Specific research goals include: quantifying the home range of this species; characterizing foraging, breeding and egg laying habitats; mapping out hibernacula sites; and defining associations with key prey species or with rodents whose burrows provide important habitat.
- Once sufficient information has been collected, HSI models should be developed for hognose snakes within the Milk River Basin. HSI models provide a valuable planning tool for land managers.
- Conduct applied research to understand how livestock grazing influences hognose snake foraging, thermoregulation, breeding and overwintering habitat quality and prey availability.
- To study the effects of grazing, research should be conducted in areas known to support healthy snake populations and which have representative areas of light, moderate and heavily grazed pastures in varying range conditions (Wright 1998)

8.2 Plains Spadefoot Toad and Great Plains Toad

- Conduct monitoring on a regular basis to assess population sizes and trends of spadefoot toad and great plains toad populations in the Milk River Basin. Taylor and Downey (2003) recommend re-surveying the Milk River Basin in 3 to 5 years (from 2002) to determine changes in the distribution and abundance of breeding spadefoot and great plains toads. Monitoring efforts should encompass both drought and high precipitation years. Monitoring efforts should attempt to determine the number of breeding populations of toads in the Milk River Basin, the response of these populations to drought, and the ability of these populations to interact through immigration or emigration (James 1998).

- Identify, map and monitor important wetlands that are consistently used for breeding by large numbers of great plains toads or spadefoot toads.
- Assess the proximity of overwintering sites to breeding sites.
- Assess seasonal habitat selection, movement patterns, home range size and overwintering requirements (Lauzon 1999).
- Determine the preferred vegetation cover characteristics in toad summer habitats (*i.e.,* percentage of bare ground versus graminoid, forb or shrub cover).
- Investigate the importance of rodent burrows as overwintering sites for spadefoot and great plains toads (Breckenridge and Tester 1961, Didiuk 1999, Didiuk pers. comm.).
- Determine minimum habitat patch size requirements and assess the effect of habitat fragmentation on toad movements and population dynamics.
- Investigate the effects of herbicide and pesticide contamination of breeding habitats on toad survival and reproductive success.
- Evaluate the effect of water management projects (*i.e.,* damming, dugouts, or creation of permanent wetlands in temporary wetland basins) on reproductive success and overwintering survival.
- Evaluate the effect of water quality on great plains toad reproductive successs.
- Compare spadefoot and great plains toad reproductive success and population dynamics in wetlands that receive heavy, light or no use by livestock during the breeding period.
- Investigate the effect of livestock disturbance and soil compaction on the availability of suitable burrowing sites for toads.

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C: NORTHERN LEOPARD FROG

1 INTRODUCTION

1.1 Background

The purpose of this report is to summarize the ecology and habitat requirements of the northern leopard frog (*Rana pipiens*) in southern Alberta. Based on this information and supporting scientific studies, various grazing systems are compared in terms of their potential implications to northern leopard frogs and their habitat. This discussion is followed by a summary of recommended beneficial management practices to protect northern leopard frogs and their habitat in the Milk River Basin and throughout the Grassland Natural Region of Alberta (Alberta Environmental Protection 1994). Lastly, a brief summary of additional information needs is presented.

Although formerly common and widely distributed in Alberta, significant declines in northern leopard frog populations occurred in the late 1970's and early 1980's (Roberts 1992, Alberta Sustainable Resource Development (SRD) 2003). Since this time populations have remained at low levels in parts of southern Alberta and the species has been extirpated from much of western and central Alberta. Widespread population declines in Alberta during the 1970s coincided with similar massive declines in leopard frog populations in the upper Midwestern states and the other prairie provinces (SRD 2003). Due to severe contraction of range and loss of populations, the leopard frog has been designated as a "Threatened" species under Alberta's *Wildlife Act* and is considered "At Risk" of extirpation in Alberta at the general status level (SRD 2001a). The Committee on the Status of Wildlife in Canada (COSEWIC) designated the northern leopard frog as a species of "Special Concern" in Alberta in 2002 (COSEWIC 2002).

The current range of the leopard frog is primarily restricted to the south and southeast portions of Alberta. The most recent leopard frog population inventory was conducted in Alberta in 2000 and 2001 (Kendell 2002a). Leopard frogs were observed at 54 of 269 historic and recent sites (Kendell 2002a). Leopard frogs were found to be closely associated with major river drainages, including the Oldman, the lower Red Deer, the Milk, the South Saskatchewan, and the lower Bow. Other sites with leopard frogs included the Cypress Hills region and the extreme northeast region of Alberta. Based on this survey it appears that leopard frogs have not re-colonized formerly occupied areas (Kendell 2002a). Moreover, it appears that further extirpation of leopard frogs has occurred in sites located south of Lethbridge, as well as south and west of Calgary. The occurrence data collected during this inventory did not allow for an accurate assessment of leopard frog population size (SRD 2003).

Although the exact cause of population declines is unclear, from their widespread nature and severity it would appear that these declines are not part of a regular cycle (SRD 2003). A combination of limiting factors, acting in unison or alone, may be responsible for the plight of the leopard frog. Proposed anthropogenic factors include: habitat loss or fragmentation; wetland drainage, eutrophication, acidification or pesticide contamination; water diversion, draw-downs or flooding (such as from dams or reservoirs); increased ultraviolet radiation due to reduction in the ozone layer; acid rain and pollution; livestock disturbance; road kills; harvest; and exotic species and game fish introduction (SRD 2003). Drought and disease are considered the primary natural limiting factors affecting leopard frog populations (SRD 2003).

In an effort to re-establish populations in historical habitats a reintroduction project was initiated in 1999 by the Fish and Wildlife Division and the Alberta Conservation Association. Over a three year period since 1999, more than 4,500 captive-reared leopard frogs were released into historical habitat in the upper headwaters of the Red Deer River near Caroline, Alberta (Kendell 2002b). In 2001, 750 frogs were released at a pilot release site in the upper headwaters of the North Saskatchewan River. Monitoring is ongoing to asses the success of reintroduction efforts (Kendell 2002b).

1.2 Ecology

In Alberta, northern leopard frogs are active from April to October (SRD 2003). Leopard frogs hibernate underwater over the winter. Frogs emerge from overwintering sites in the spring shortly after the ice begins to melt. Breeding occurs from late April to late June during optimal temperatures. Depending on environmental conditions, breeding may last only a few days or occur intermittently over several weeks. Mating typically begins when sexually mature males arrive at the breeding pond and start to call while floating on the surface. Sexually mature females join them at the pond a few days to a few weeks later to lay their eggs. Eggs are laid in one mass containing between 600 to 7,000 eggs. Females are thought to produce one clutch per year. Hatching can occur 5 to 9 days after egg laying, depending on water temperature (Hine *et al.* 1981). Flooding, drought, or cold temperatures can result in egg mortality or loss of entire clutches. Tadpoles disperse from egg masses a few days after hatching. It takes 60 to 90 days for tadpoles to metamorphose, with metamorphosis generally taking place in July and early August in Alberta (SRD 2003). Following breeding, adults usually remain near breeding ponds or disperse to summer feeding areas (Dole 1967, SRD 2003). Adults move to overwintering sites in late summer or early fall (SRD 2003).

Leopard frogs usually become sexually mature in their second year, however, reaching this stage depends more on body size than age (Corn and Livo 1989). Environmental conditions affect growth rate, which may vary from year to year.

1.2.1 Diet

Northern leopard frogs shift from a herbivorous diet of vegetation and algae as tadpoles to a carnivorous diet at metamorphosis (Fisher 1999). Adult frogs have a broad diet consisting primarily of invertebrates (Fisher 1999). Adults have also been known to prey on small birds, garter snakes and fish and may occasionally cannibalize newly transformed young leopard frogs (Russell and Bauer 2000, SRD 2003).

1.2.2 Predators

Northern leopard frog predators include fish, great blue herons (*Ardea herodius*), belted kingfishers (*Ceryle alcyon*), shrews (*Sorex* spp.), weasels (*Mustela* spp.), red fox (*Vulpes vulpes*), and coyotes (*Canis latrans*) among others (Fisher 1999).

1.3 Habitat Requirements

1.3.1 General

A northern leopard frog needs up to three distinct habitat types: a breeding water body in the spring for mating, deposition of eggs, and development of tadpoles; upland habitat and adjacent habitat near water for foraging during mid summer; and a water body that does not freeze solid in the winter so that they may hibernate (Kendell 2002c). In Alberta, northern leopard frogs are generally associated with clear water that is "relatively fresh to moderately saline" (SRD 2003).

1.3.2 Overwintering

Northern leopard frogs overwinter in well-oxygenated water that does not freeze to the bottom such as in springs, streams or in deeper lakes and ponds (SRD 2003). As leopard frogs absorb oxygen through their skin during hibernation underwater, they are susceptible to mortality due to anoxic water conditions or the complete freezing of waterbodies (Kendell 2002c). Springs are considered a critical overwintering habitat in southern Alberta, particularly during periods of prolonged drought when deeper water bodies become scarce (Didiuk 1999, SRD 2003). Frogs hibernate under rocks, logs, leaf litter or vegetation, or in depressions in sand or mud (SRD 2003).

1.3.3 Breeding

Separate sites are typically used for overwintering and breeding although occasionally, especially in spring-fed wetlands, the same water body may be used (Didiuk 1999, SRD 2003). Northern leopard frogs usually breed in shallow and warm standing water such as in permanent and semi-permanent wetlands, marshes, sloughs, dugouts, springs, lake margins and shallow bays, beaver ponds, slow flowing creeks, and the backwaters and oxbows of rivers (Cottonwood Consultants 1986, Kendell 2002c, SRD 2003). In the Suffield National Wildlife Area (SNWA), leopard frogs were restricted in their distribution to meander scar wetlands along the South Saskatchewan River floodplain and small drainages flowing into the river (Didiuk 1999).

According to Kendell (2002c), ideal breeding habitat has the following characteristics:

- some degree of permanence (*i.e.,* it is unlikely to dry up before tadpoles metamorphose);
- abundant aquatic and emergent vegetation;
- shallow open water that receives direct morning and afternoon sunlight;
- standing water that freezes solid during most winters or dries up every few years to prevent or reduce predatory fish establishment;
- non-acidic water (*i.e.,* pH range between 6.5 to 8.5);
- shallow water depths between 10 cm to 65 cm;
- a gradual sloping shoreline to support emergent and upland vegetation; and
- is located within 1.6 km of over-wintering habitat.

Northern leopard frogs lay their egg masses in shallow water on vegetation and occasionally on the pond bottom (SRD 2003). Gilbert *et al.* (1994) found that leopard frog egg masses were deposited at depths less than 65 cm after the water temperature reached 8 degrees Celsius. Slow flowing or stagnant water bodies that contain water until late July or August and that are unsuitable for fish are considered favourable leopard frog spawning sites. Preferred spawning habitats often include areas dominated by herbaceous non-emergent plants such as sedges (*Carex* spp.) and emergent plants such as cattails (*Typha* spp.) which provide points of attachment for egg masses (Hine *et al.* 1981, Gilbert *et al.* 1994).

1.3.4 Foraging (Non-breeding) Habitat

Leopard frog summer feeding sites are most often located near water bodies and consist of open and semi-open areas with intermediate vegetation heights (SRD 2003). Vegetation cover and proximity to water are important for predator avoidance. Summering habitat may be found at greater distances (1 km to 2 km) from waterbodies in areas that have sufficient moisture such as wet meadows, pastures, and drainage and irrigation ditches (Kendell 2002c). Leopard frogs avoid areas with little or no vegetation cover (*i.e.,* heavily grazed fields, mowed lawns or recently hayed or harvested fields) or areas with tall, dense marsh vegetation, grasses or extensive shrub or woody cover (Merell 1977, SRD 2003). McAlpine and Dilworth (1989) noted that leopard frogs were found in vegetation with a mean height of 32 cm and a range of 9 cm to 85 cm. Dole (1965a) found that in fair weather in summer, leopard frogs were quite sedentary and spent the majority of a day sitting in “forms” created by clearing wet soil of dead vegetation. Leopard frogs will sit motionless waiting for prey items to come within range.

1.3.5 Dispersal

Seburn *et al.* (1997) studied leopard frog dispersal on the southern slopes of the Cypress Hills in southern Alberta. Their study showed that streams provide important dispersal corridors for frogs in prairie environments. Seburn *et al.* (1997) suggest that aquatic routes may provide the required environmental cues and moisture to increase the number of days in which frogs can disperse. Ambient temperature and rainfall or humidity are other factors affecting dispersal of leopard frogs (Seburn *et al.* 1997).

1.3.6 Area Requirements

Adult northern leopard frogs reportedly establish home ranges in the summer, with home ranges varying in size depending on habitat availability (Dole 1965b). Dole (1965b) studied leopard frog home ranges in two study areas in Michigan. In one study area suitable habitat was more widespread and less confined and ponds were less readily available than in the second study area (Dole 1965b). Home ranges were larger in the first study area and increased in size with increasing frog body size, ranging from 283 m^2 for subadults, 362 m^2 for adult males, and 503 m^2 for adult females. In the second study area, home ranges varied from 68 m^2 for subadults, 78 m^2 for adult males, and 113 m^2 for adult females. Once adult frogs establish home ranges they reportedly return to the same region each summer (Dole 1965b). As described by Dole (1965b), home range size may be affected by several factors, including the degree of crowding, the amount of cover, the abundance of food, or the availability of moisture.

In the Cypress Hills, a young-of-the-year (YOY) frog was found to travel a distance of 8 km from its natal pond over the course of two active seasons (Seburn *et al.* 1997). In general, YOY frogs in the Cypress Hills traveled up to 2.1 km downstream, and 1.0 km upstream (Seburn *et al.* 1997). Frogs dispersed over lesser distances (0.4 km) overland (Seburn *et al.* 1997). The majority of young frogs dispersed to ponds within 1 km within 3 weeks of metamorphosis

(Seburn *et al.* 1997). In Michigan, Dole (1971) reported that YOY frogs dispersed up to 800 m per night. He also recorded overland travel of up to 5 km by two adults.
Based on known dispersal distances of 1.6 km to 2.0 km over the course of a single active season, leopard frogs in Alberta may occupy up to 12.6 km ^{2} at any given specific site, if suitable habitat is present (SRD 2003).

1.4 Northern Leopard Frog Response to Livestock Grazing

Intensive livestock grazing in riparian areas is most likely to have a detrimental impact on leopard frogs and their foraging, breeding and overwintering habitat (Wershler 1991, SRD 2003). Heavy grazing and trampling in riparian areas can reduce the quality of summer habitats by damaging foraging and shelter sites due to reduced vegetation cover and diversity, and creation of drier soil conditions (SRD 2003). Concentration of cattle around wetlands or along rivers not only reduces non-emergent bank vegetation, but can result in trampling or grazing of emergent vegetation and aquatic plants. This can alter and damage protective, reproductive and larval microhabitats and increase risk of predation on adult frogs and tadpoles (Jansen and Healey 2003). Trampling along the shore and in the water can also increase water turbidity and erosion with possible negative consequences for tadpole and egg development (SRD 2003). Movements along the shoreline can additionally result in egg masses being dislodged or trampled causing direct mortality or harming egg development (SRD 2003). Didiuk (1999) reported that significant amphibian larvae mortality resulted from heavy livestock trampling of shoreline vegetation, high turbidity of water, and poor water quality from cattle feces in wetlands in the SNWA. Other potential impacts include deposition of livestock feces and urine in overwintering ponds that can cause increased nutrient levels and an increased likelihood of anoxic conditions leading to winterkill (SRD 2003).

Impacts of grazing on wetlands and their associated frog communities are largely dependant on the level of grazing intensity A study in an Australian floodplain revealed that frog communities, species richness, and individual species of frogs declined with increased grazing intensity as did the wetland condition (water quality and aquatic vegetation components) (Jansen and Healey 2003). Reduced stocking rates and rest periods from grazing were suggested to improve wetland condition and increase frog production.

As leopard frogs coexisted with bison throughout much of their historical range in North America, this species is adapted to periodic disturbance, and appears to require some degree of herbivory to maintain intermediate vegetation heights and to create openings in dense cover that can be used for basking or foraging (Kendell pers. comm.). Therefore, complete exclusion of livestock from riparian habitats may improve the quality of habitat for leopard frogs in the short-term, but may have negative long-term effects (Kendell pers. comm.). Exclusion of livestock from riparian areas over the long-term leads to tall and dense vegetation cover in these areas that may impede the movement or foraging ability of leopard frogs or reduce the availability of suitable basking sites (Kendell pers. comm.). This scenario has been observed at the Prince's Spring area of the Remount Community Pasture in Alberta, a productive leopard frog breeding and overwintering site that has been fenced out from grazing since the late 1980's (Hofman, pers. comm.). Although leopard frog populations are still healthy at this site, limited, late fall grazing is being considered to selectively open up and reduce vegetation density along the springs (Hofman pers. comm.). Fall grazing is also being considered as a tool to reduce the encroachment of tall, dense patches of reed canary grass (*Phalaris arundinacea*) in the Creston Valley Wildlife Management Area in British Columbia (Waye and Cooper 2001, D. Adama pers. comm.). Reed canary grass, a non-native species, has overgrown and displaced native vegetation along certain watercourses used by leopard frogs in this area. Leopard frogs appear to be excluded from areas with dense reed canary grass cover (Waye and Cooper 2001). Carefully managed, cattle grazing in this instance may improve summer habitats and seasonal movements of leopard frogs.

Controlling the timing and intensity of livestock use in critical leopard frog habitats is important for maintaining or enhancing the quality of these habitats (Kendell pers. comm.). Grazing impacts should be restricted or minimized during sensitive periods near critical habitats. Heavy use early in the season (April to May) is likely to have the most severe detrimental effects in terms of causing erosion or damaging breeding habitats and spawning micro-sites (Kendell pers. comm.). Mid summer grazing (June to July) may be less harmful as leopard frogs are more dispersed at this time of year in non-breeding areas and YOY have not yet emerged (Hofman pers. comm., Kendell pers. comm.). Grazing near breeding ponds in August may have an impact on the suitability and security of these sites for YOY frogs which emerge in large numbers at this time and stay close to breeding ponds. In September or October, grazing effects near breeding ponds are less of a concern unless these areas are also used for overwintering (Kendell pers. comm.). Grazing use near overwintering water bodies early in the fall is not desirable as frogs congregate at these sites at this time of year. Winter grazing of riparian areas (*i.e.,* during frozen ground conditions), where feasible, may have the least detrimental consequences to leopard frogs and could be used to maintain suitable vegetation structure (Kendell pers. comm.). However, winter grazing intensity should be carefully managed. Heavy grazing during the dormant season can progressively set back woody species that play an essential role in stabilizing stream banks (Fitch and Adams 1998).

1.5 Grazing Systems and Northern Leopard Frog Habitat Management

Table III-13 provides an overview of six grazing systems and their potential positive or negative implications to northern leopard frogs and their habitat. A grazing system is a tool used to control the spatial distribution, timing, intensity, and frequency of livestock grazing (Holechek *et al.* 2003). Applied research is needed to properly assess the effects of various grazing systems on northern leopard frogs in the Milk River Basin.

Table III-13 Grazing Systems and Northern Leopard Frog Habitat Management

Grazing System	Discussion
Continuous (Season-Long) Grazing	
Advantages:	Continuous grazing can be compatible with maintaining leopard frog habitats if stocking rates are low and stock water is available away from critical leopard frog habitats to minimize use in these areas.
Disadvantages:	Continuous grazing can be particularly damaging to riparian areas as livestock will congregate and linger near water throughout the duration of the grazing season from spring to fall (Ohmart 1996, Fitch and Adams 1998, Holechek *et al.* 2003). For this reason, continuous grazing nearly always results in overuse of riparian areas (Ohmart 1996). Heavy, persistent grazing in riparian areas can result in trampling and removal of vegetative cover, increased erosion and degraded water quality. This can have a negative impact on critical leopard frog overwintering, breeding and foraging habitats and can result in diminished leopard frog reproductive success or survival (SRD 2003). The degree of damage to leopard frog habitats under continuous grazing depends on grazing intensity, the effectiveness of grazing distribution techniques, and the availability of alternate stockwater sources away from critical habitats. Continuous grazing effects are generally more severe in well developed riparian areas in complex range landscapes and in permanent versus ephemeral riparian areas (Fitch and Adams 1998).
Deferred Grazing	
Advantages:	Deferred spring grazing allows for deferral of grazing or trampling disturbance near riparian areas during periods when streambanks are saturated with moisture and are therefore most susceptible to erosion. Reduced erosion will help to improve water quality for leopard frog egg and tadpole development. Deferred spring grazing also minimizes impacts to aquatic or emergent vegetative cover during the critical leopard frog breeding period. Aquatic and emergent vegetative cover is important spawning habitat as it provides a surface for egg masses to attach to and offers shelter from predators. Deferred use during the spring has the added benefit of reducing risks of direct mortality to adults or egg masses from trampling.
Complementary Grazing	
Advantages:	Complementary grazing, a form of deferred grazing, allows for deferred grazing of native prairie until June, with seeded pasture grazed earlier in the season. As discussed above, deferral restricts cattle use of critical breeding habitats during the most sensitive spring period.
Disadvantages:	Complementary grazing requires the use of seeded pasture which may not be available in all grazing systems. Seeded pasture is often not suitable in many places in the mixedgrass or dry mixedgrass prairie due to fragility of soils and dry conditions. Tall and dense seeded pasture cover may impede leopard frog dispersal or diminish the quality of foraging or dispersal habitats (SRD 2003).
Rotational Grazing	
Advantages:	Rotational grazing systems including rest or deferred rotation grazing are considered beneficial to restoring or maintaining the health of riparian areas (Fitch and Adams 1998). Rest-rotation grazing systems incorporate one or more years of rest into the grazing rotation. This allows for non-use during the growing seasons, permitting the recovery of degraded riparian areas by facilitating the growth and regeneration of herbaceous and woody vegetation. Deferred-rotation grazing allows the riparian area to be periodically rested and grazed later in the season. Introducing rest periods and deferring use during the critical spring period allows for improved

Grazing System	**Discussion**
Rotational Grazing Cont'd.	
Advantages:	vegetation cover and bank stability, reducing sediment loads entering the water. This subsequently reduces trampling risks to egg masses during the spring, offers improved foraging and shelter micro-sites for leopard frogs during the summer, and may improve water quality. An overall improvement in water quality from lesser amounts of fecal contamination reduces the risk of anoxic conditions over the winter in leopard frog overwintering habitats.
Disadvantages:	The benefits of rotational grazing systems not only depend on timing grazing use of critical habitats to coincide with less sensitive periods, but are also dependant on stocking rates. At heavy stocking rates, impacts to critical habitats will increase and longer periods of recovery may be required. Reduced cover in upland areas due to heavy stocking rates also diminishes predator escape cover for dispersing leopard frogs and leaves them more prone to desiccation (Kendell pers. comm.).
Intensive Grazing	
Advantages:	Intensive, short periods of grazing in the fall may be beneficial in terms of reducing encroachment of tall exotic grasses such as reed canary grass in leopard frog foraging areas or dispersal corridors (Waye and Cooper 2001).
Disadvantages:	Most intensive grazing systems involve high stocking rates and high rates of forage utilization followed by periods of rest. The impact of this type of grazing system on leopard frogs can be severe if use is concentrated near breeding ponds, foraging habitat or water bodies used for overwintering. Under high stocking rates, risks of dislodging or trampling egg masses are increased and there is a greater potential to reduce water quality due to erosion, intense removal of vegetation cover and high amounts of fecal contamination. Leopard frogs typically avoid heavily grazed areas when foraging and require an abundance of aquatic plants, emergent vegetation and moisture tolerant grasses to provide optimal spawning habitat (Kendell 2002b).
Riparian Area Grazing	
Advantages:	As the goal of riparian area grazing systems is to improve the overall health of riparian areas, these systems have obvious benefits to leopard frogs. Improved vegetation cover, water quality, and sediment trapping ability are some of the positive outcomes of a well managed riparian area (Fitch and Adams 1998). These factors will improve the quality of leopard frog breeding, foraging and overwintering habitat.
Disadvantages:	Regeneration of woody vegetation and recovery of heavily degraded riparian areas may require lengthy periods of rest. For example, Homyack and Giuliano (2002) found that reptiles and amphibians in Pennsylvania may require more than 4 years to respond to streambank fencing. In prairie ecosystems, herbaceous plant communities that are dominated by exotic invasive graminoids will thrive with exclusion from grazing and are unlikely to revert back to a native plant community. Common invasive graminoids along riparian channels in southern Alberta include smooth brome (*Bromus inermis*) and Timothy grass (*Phleum pratense*). The impact of these exotic species on leopard frog foraging or dispersal behaviour requires further study.

1.6 Beneficial Management Practice Recommendations

In order to meet the annual requirements for all life history stages, the northern leopard frog requires a mosaic of critical habitat types for overwintering, breeding, and foraging (SRD 2003). These critical habitat types should be monitored, protected, and well managed. Landscape connectivity between these habitats should also be maintained to ensure that leopard frogs can move between them (Pope *et al.* 2000). Facilitating dispersal is important to stabilize populations at a larger metapopulation scale, recolonize formerly extirpated sites, and to maintain genetic connections between extant populations (Seburn *et al.* 1997, Pope *et al.* 2000). It is therefore important not to focus on simply protecting key habitats as isolated units, but rather to promote leopard frog recovery efforts by considering the constraints of the entire landscape (Pope *et al.* 2000).

The following general land use and grazing recommendations provide a variety of means by which to protect or enhance northern leopard frog habitats. These recommendations apply to leopard frog populations within the Milk River Basin and throughout the Grassland Natural Region of Alberta. Further research is required (Section 1.7) to improve our understanding of leopard frog ecology and their response to land use activities, such as livestock grazing, in the Milk River Basin.

1.6.1 General Recommendations

- Avoid cultivation of native prairie habitats that connect or contain suitable leopard frog breeding, foraging or overwintering habitats. Cultivation not only results in loss of suitable habitat by draining wetlands, or disturbing upland foraging sites, but also fragments and isolates remaining habitats, possibly impeding leopard frog dispersal and gene flow.
- Reclaim drained wetlands that provided former leopard frog habitat and protect existing wetlands from being drained, plowed or structurally disturbed. Wetland drainage has been extensive in southern Alberta over the past 50 years due to agricultural activities (SRD 2003). Protecting buffer zones around wetlands and maintaining connectivity between different types of wetlands that form part of the habitat mosaic used by leopard frogs over the year is important.
- Protect key breeding ponds, foraging habitats and overwintering sites from disturbance and monitor their condition (Seburn *et al.* 1997, SRD 2003).
- Avoid the use of pesticides or herbicides or chemical nitrogen-based fertilizers in the vicinity of breeding ponds or other critical leopard frog habitats (Quellet *et al.* 1997, Christin *et al.* 2003). While the effects of agro-chemicals is still being studied, chemical contamination is suspected to have negative consequences for frog reproduction, development and immune response, and may lead to anoxic conditions in overwintering habitats (Quellet *et al.* 1997, Christin *et al.* 2003, SRD 2003).
- Observe SRD, Fish and Wildlife Division setbacks from ponds used by leopard frogs for living, breeding or hibernating (SRD 2001b). SRD recommends a year-round setback of 100 m from leopard frog ponds for industrial developments, including road and pipeline construction. Where possible, to minimize potential impacts to leopard frogs, pipelines near leopard frog ponds should be constructed during frozen ground conditions in the winter. If

construction occurs during the summer, trenches should be regularly checked for leopard frogs.

- Conduct pre-development wildlife surveys to locate leopard frog ponds in areas with suitable habitat.
- Avoid the creation of new dams or reservoirs along drainages known to support leopard frog populations. Dams and reservoirs often impede natural seasonal inundation of floodplain wetlands and can therefore negatively affect leopard frog breeding habitats and diminish reproductive success.
- Prevent the introduction of game fish and exotic species into leopard frog habitats (SRD 2003).
- Continue public information and education campaigns to promote awareness about the leopard frog and to encourage support in maintaining and monitoring leopard frog populations and their habitats.

1.6.2 Grazing Recommendations

Grazing systems that result in an improvement in wetland condition or improved riparian health will likely benefit leopard frogs. Heavy livestock use near riparian areas can be particularly harmful in the spring when banks are saturated and are susceptible to erosion and leopard frogs are concentrated at breeding sites. It is particularly important to monitor and manage grazing impacts near to permanent water bodies such as spring fed wetlands and along oxbows and meander scar wetlands in river floodplains that may provide overwintering and breeding habitat. Minimizing trampling along shorelines, maintaining vegetation cover (including aquatic and emergent vegetation), and improving water quality will benefit leopard frogs. Managed properly, grazing can be compatible with maintaining and possibly improving leopard frog habitat. Appropriate grazing systems for leopard frogs should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

The following recommendations consider grazing management practices that can be used to improve the quality of leopard frog habitats.

- Use low to moderate stocking rates in pastures that contain or connect critical leopard frog breeding, foraging and overwintering habitats (Didiuk 1999). Adjust stocking rates during drought conditions.
- Observe utilization rates of 40% for fescue prairie and 50% for mixedgrass and dry mixedgrass prairie to ensure adequate carry-over of residual vegetation and litter (Adams *et al.* 1994). This will help to prevent uniform grazing effects and retain sufficient upland cover for leopard frogs dispersing overland. Sufficient cover offers shelter from predators and helps to prevent desiccation of frogs.
- Observe conservative utilization rates (25% to 50%) in riparian habitats where leopard frogs occur to ensure that vegetative cover remains intact (Fitch and Adams 1998).

- Place salt or mineral sources at least 1 km from natural water bodies, where possible (Adams *et al.* 1986). Placing salt away from water forces cattle to make better use of the range and reduces the amount of time cattle spend at water sources.
- Provide alternate watering sites (i.e., dugouts or troughs) to reduce impact to sensitive leopard frog ponds, streams or other natural riparian habitats. Cattle have been shown to prefer drinking from a water trough and will travel further to a trough rather than drink from a stream when given free access to both (Veira 2003). Off-site watering can provide a more reliable and cleaner water source for cattle. Improved water quality can improve livestock health and weight gain (Veira 2003).
- Off-site watering systems and salt placement are particularly effective tools in relatively flat prairie, however, in variable terrain, additional methods (as described below) may be required to improve cattle distribution and minimize impact to critical leopard frog habitats.
- Provide graveled or hardened access points for livestock at select points along a stream or river away from productive leopard frog breeding or overwintering habitats. This focuses cattle use at a few predetermined locations and reduces sedimentation of water courses.
- Use rest- or deferred- rotation grazing systems to ensure sufficient periods of rest and recovery in riparian areas.
- Defer use near riparian areas during vulnerable periods in the spring when stream banks are soft and are susceptible to slumping and erosion. Heavy trampling in the spring poses a particular threat to spawning adult leopard frogs, egg masses, and tadpoles in breeding habitats.
- Avoid heavy impacts to breeding ponds in August to prevent trampling and conserve vegetation cover for emerging YOY frogs.
- In areas with distinct upland and lowland areas, explore the use of riparian pastures to defer use in riparian areas during the spring. Riparian pastures are created by fencing upland terrain and riparian landscape units separately (Fitch and Adams 1998).
- Fence out select riparian areas (such as spring-fed overwintering streams or breeding ponds) to restore water quality or vegetation cover or to prevent damage at key times of the year (i.e., during breeding). Monitor fenced out sites to ensure that vegetation growth does not exceed the threshold required for leopard frog foraging or movement.

1.7 Research Recommendations

Ongoing monitoring is needed to continue to assess the status of leopard frogs in Alberta and to evaluate the long-term success of leopard frog reintroduction efforts at the Raven River and North Saskatchewan River release sites. Based on the success of current projects, additional reintroduction sites in the Milk River Basin could be explored.

In addition to continued monitoring, further research is needed to investigate leopard frog ecology and the effects of land use activities on leopard frog reproductive success, survival, and dispersal. The effectiveness of various riparian area grazing strategies should be investigated in terms of their benefits to leopard frogs. The role of grazing in maintaining summering or dispersal habitats for leopard frogs also requires study. To assess the impact of grazing on summering habitats, research is first needed to further characterize leopard frog summering habitats and dispersal patterns in the Milk River Basin and to assess the impact of herbaceous exotic species invasion. Leopard frog dispersal studies may provide insight into mitigation measures that are needed to reduce landscape barriers from human activities and restore habitat connectivity. Collectively, these types of studies will help to refine land use and grazing management recommendations for enhancing or protecting leopard frog habitats.

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IV: OTHER

A: WESTERN SMALL-FOOTED BAT AND WEIDEMEYER'S ADMIRAL BUTTERFLY

1 INTRODUCTION

The purpose of this report is to summarize the ecology and habitat requirements of the western small-footed myotis [w. small-footed bat] (*Myotis cilolabrum cilolabrum*) and the Weidemeyer's admiral butterfly (*Limenitis weidemeyerii*) in southern Alberta. Based on this information and supporting scientific studies, the potential effects of livestock grazing on these species and their habitats is assessed. This discussion is followed by a summary of recommended beneficial management practices to enhance habitat for w. small-footed bats and admiral butterflies in the Milk River drainage in Alberta. Lastly, a brief review of key research recommendations is given.

Weidemeyer's admirals and w. small-footed bats are considered together in this report due to their shared reliance on similar riparian sites and the implications this has on management recommendations. Riparian, deciduous forests and shrubby vegetation along river and coulee valleys as well as spring or seepage sites provides key habitat for Weidemeyer's admirals and important foraging habitat for w. small-footed bats. Due to the potential for livestock grazing to impact the quality of these riparian habitats, it is important to consider management strategies that aim to balance livestock use with sustained riparian health. It is also important to consider strategies to minimize potential impacts due to other human activities, such as industrial development or water diversion projects, which can pose a risk to these species or their habitats.

2 WESTERN SMALL-FOOTED MYOTIS (BAT)

2.1 Background

The w. small-footed bat, Alberta's smallest bat, has a characteristic dark brown mask that spans from ear to ear, and true to its name, it has noticeably small hind feet (Pattie and Fisher 1999, Lausen 2003). This species ranges across much of western North America, from central British Columbia, southern Alberta and southwestern Saskatchewan, south to the central States of northern Mexico (Holloway and Barclay 2001, Schmidt 2003). There are two subspecies of the w. small-footed bat, the *M.c. melanorhinus* found in British Columbia, and the *M. c. ciliolabrum* which occurs in Alberta and Saskatchewan (van Zyll de Jong 1985). Within Alberta, w. small-footed bats have been found along the Red Deer, South Saskatchewan, Oldman and Milk river valleys (Schowalter and Dorward 1978, Engley and Norton 2001, Lausen 2003). Their distribution extends north to Rumsey and west to Lethbridge (Smith 1993). This species is thought to be widespread in the badlands and semi-arid river valleys of the Milk River area (Pybus 1986).

Little information is available regarding w. small-footed bat population sizes or trends in Alberta (Alberta Sustainable Resource Development (SRD) 2001a). As their populations appear to be clumped and disjunct due to their reliance on prairie riverine habitats (including cottonwoods and cliffs), habitat security is a concern (SRD 2001a). Consequently, this species is designated as “Sensitive” in Alberta at the general status level (SRD 2001a). This species is not currently ranked by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2003a). More research is needed to understand the effects of land use practices on bats. W. small footed bats are ultimately limited by the availability of suitable roosting and foraging sites in prairie riverine environments. The presence of secure roosting sites, in particular, can strongly influence bat populations (Bogan *et al.* 1996). Industrial development and urbanization, agricultural expansion, livestock grazing, and damming and water diversion projects can result in the loss or degradation of roosting or foraging habitats along riparian corridors (Chung-MacCoubrey 1996, Holloway and Barclay 2000, Lausen 2003). The use of pesticides and herbicides may also detrimentally affect bats by reducing populations of aquatic insects (Forsyth 1993, 1996, Holloway and Barclay 2000).

2.2 Ecology

Bats typically enter hibernation in late autumn and reemerge in March (Holloway and Barclay 2001). Bats rely on the fat reserves they accumulate in late summer and early fall to survive during the hibernation period (Barclay 1993). Mating usually occurs prior to hibernation in late August or early September (Nagorsen and Brigham 1993). Females store sperm until the next spring, in approximately eight months time (Schowalter and Allen 1981). Most births occur from mid-June to mid-July, although parturition dates vary across the geographic range of the w. small-footed bat (Nagorsen and Brigham 1993, Holloway and Barclay 2001). Cold, wet spring conditions may delay birthing if females go into torpor (a state of reduced body temperature and metabolism) (Barclay 1993). Bats have an extremely low reproductive rate. Females give birth to one litter per year, with one offspring produced, although twins are possible (Holloway and Barclay 2001). In general, young bats first fly toward the end of July or early August when they reach three to five weeks of age (Barclay 1993, Lausen pers. comm.).

2.2.1 Diet

Flying insects are the main food source of w. small-footed bats (Holloway and Barclay 2001). Lepidoptera (butterflies and moths), Diptera (flies), Hemiptera (true bugs), and Coleoptera (beetles) are the main orders of insects consumed. Like most prairie bats, w. small-footed bats forage at night while in flight, with peak foraging occurring in the first few hours after sunset (Barclay 1993). Aerial insects are detected using echolocation, whereby bats emit a series of short, high-pitched sounds which then bounce off objects and surfaces in their path creating an echo (Barclay 1993). Bats can determine an object's size, shape, direction, distance, and motion by the reflected sounds.

2.2.2 Predators

Few reports of predation on w. small-footed bats are available. Common bat predators include raccoons, owls and snakes (Schmidt 2003).

2.3 Habitat Requirements

2.3.1 General

The w. small-footed bat is common in badland, arid desert and semi-arid habitats in most of its range (Holloway and Barclay 2001). In southeastern Alberta, this species tends to occupy riparian zones in badland and grassland areas (Holloway and Barclay 2001). River valleys or coulees with sandstone cliffs, rocky outcrops or eroded mudstone slopes (*i.e.,* badland formations) offer favourable roosting habitats for these bats. Riparian cottonwood forests near to suitable roosts provide important foraging sites for w. small-footed bats in prairie landscapes (Holloway and Barclay 2000).

The habitat suitability index (HSI) model developed for w. small-footed bats in the Milk River Basin included three, equally weighted variables: terrain slope, rock outcrops and exposed soil, and distance to water (Landry 2004). According to this model, areas best suited to w. small-footed bats include badland areas with shallow to bedrock soils and slopes greater than 10 degrees that are located less than 1 km from water. Presence of riparian trees (*i.e.,* cottonwoods) was another variable considered for inclusion in the model but for which an appropriate Geographic Information System (GIS) data layer was not available (Landry 2004).

2.3.2 Foraging Habitat

Bat foraging activity is strongly related to the distribution and abundance of invertebrate prey (Holloway and Barclay 2000). W. small-footed bats typically forage over natural and man-made water sources and along the margin of trees (Holloway and Barclay 2000). Water sources are important to these bats as many invertebrate prey require water at various stages of their lifecycle (Holloway and Barclay 2000). Due to this association, moist riparian habitats along rivers, wetlands or springs often provide high insect abundance (Holloway and Barclay 2000). In southeastern Alberta, Holloway and Barclay (2000) noted a significant decrease in bat activity as distance from water increased. Bats were rarely found more than 1 km away from a water source (Holloway and Barclay 2000). Total insect biomass was found to be greatest along rivers and at springs in this study (Holloway and Barclay 2000). Water sources such as rivers and springs are not only important foraging sites but are also used for drinking (Holloway and Barclay 2000). Bats can experience severe evaporative water loss while in diurnal roosts in hot weather (Holloway and Barclay 2000). Thus, in hot, arid areas, water availability may be a significant limiting factor to bat abundance (Holloway and Barclay 2000).

Riparian cottonwoods in southeastern Alberta are considered especially important foraging sites for bats, providing shelter and a substrate for insects to feed upon (Holloway and Barclay 2000). Foraging has also been documented along cliffs, steep banks, talus slopes and rocky outcrops (Nagorsen and Brigham 1993). Bats rarely foraged in areas of low-slope topography or over open grassland in southeastern Alberta (Holloway and Barclay 2000). Activity was highest in steep rugged areas along rivers, most likely due to the greater availability of suitable roosting sites in these areas (Holloway and Barclay 2000). Foraging usually occurs within 1 km to 2 km from bat roosting habitats (Holloway 1998, Lausen 2003).

2.3.3 Roosting Habitat

The presence of secure roosting sites strongly influences bat populations and may be another important limiting factor for prairie bat populations (Bogan *et al.* 1996, Holloway and Barclay 2000). Roosts provide shelter from inclement weather and predators and provide a secure site for resting between foraging bouts (Bogan *et al*. 1996). During the summer, w. small-footed bats often roost alone or in small groups ranging from 1 to 6 individuals (Lausen 2003, Pretzlaw *et al.* 2004 *in prep*.). These bats tend to group up more during lactation than at other times during the summer (Pretzlaw *et al.* 2004 *in prep*.). Unlike several other bat species, w. small-footed bats do not roost in trees, preferring to roost under rocks or in holes and crevices in eroded mudstone or rocky outcrops along river valleys (Nagorsen and Brigham 1993, Holloway and Barclay 2000). Summer roosts may also be found in cavities within boulders, steep banks, in the ground, or in eroded bentonite rich clay or sandstone talus slopes (Nagorsen and Brigham 1993, Lausen 2003).

Bats are known to switch roosts frequently (often daily) (Holloway 1998, Lausen 2003, Pretzlaw *et al.* 2004 *in prep*.). Bats may also use different roosting sites during the day than at night, although Holloway (1998) found that individuals in southern Alberta used their diurnal roosts as night roosts. If different sites are used, night roosts tend to be closer to foraging areas and may be relatively warmer than day roosts (Landry 2004). Night roosts are also likely to be located in larger holes such as caves that may accommodate larger groups of bats (Lausen pers. comm.). In comparison, day roosts may be found in unvegetated, eroded mudstone holes, under rocks or in smaller crevices (Lausen 2003).

2.3.4 Nursery Roosts

Nursery or maternity roosts are usually found in similar areas as night roosts, including caves or crevices in rock faces or in clay banks (Pybus 1986, Landry 2004). Maternity roosts provide secure sites for groups of females to bear and raise their young over the spring and summer (mid-June to the end of July). These sites provide protection from adverse weather and predators and are usually warm, helping to reduce the amount of energy females and young need to spend to maintain a high body temperature (Barclay 1993). Warmer temperatures thereby help to maximize fetal and juvenile growth rates (Pretzlaw *et al.* 2004 *in prep*.). As adult, and possibly juvenile, females may return to the same maternity roosts in subsequent years, it is important that these sites are protected from disturbance (Barclay 1993, Cryan *et al.* 2000).

According to a recent study of female w. small-footed bats along the South Saskatchewan River valley, summer day roosts were often found low to the ground in eroded holes with small openings in solidified bentonitic mudstone (Lausen 2003, Pretzlaw *et al.* 2004 *in prep*.). Females selected roosts with significantly smaller openings in comparison to randomly selected crevices (Pretzlaw *et al.* 2004 *in prep*.). Roosts with small openings are thought to provide added protection from predators as well as a more stable, warmer microclimate (Pretzlaw *et al.* 2004 *in prep*.). Similar roosts were selected during pregnancy and lactation and roosts on both sides of the river were used throughout these periods (Lausen 2003, Pretzlaw *et al.* 2004 *in prep*.). Roosts were found at varying elevations, from near the water's edge to 90 m above the water level (Lausen 2003). Female roost orientation and slope aspect did not differ significantly during different reproductive stages or in comparison to random sites (Pretzlaw *et al.* 2004 *in prep*.). As erosion hole roosts were used more often than any other structure, suitable female roosting habitat within the Milk River Basin is likely to be found more frequently in eroded mudstone and sandstone than in rock outcrops (Lausen 2003, Pretzlaw *et al.* 2004 *in prep*.).

2.3.5 Hibernacula

Hibernating bats require sites with stable, cool (approximately 2°C to 6°C), humid conditions (Barclay 1993). These conditions are typically found in deep caves and mines and are thought to be rare within the Canadian prairies (Barclay 1993). W. small-footed bats have been reported to hibernate in abandoned mines and caves in British Columbia, Montana and South Dakota (Nagorsen and Brigham 1993, Choate and Anderson 1997, Hendricks *et al.* 2000). More research is needed to determine where the majority of w. small-footed bats in Alberta hibernate. There is speculation these bats may over-winter in suitable sites within Dinosaur Provincial Park (Schowalter and Allen 1981, Pybus 1986, Lausen 2003). Lausen (2003) observed that w. small-footed bats were present in the Dinosaur Provincial Park area early in the spring and late into the fall after the first snowfall. Based on these observations, Lausen (2003) suggests it is very likely that bats hibernate in this area, presumably within deep crevices in badland formations that extend below the frost line (Lausen pers. comm.).

2.3.6 Area Requirements

Lausen (2003) found that female w. small-footed bats along the South Saskatchewan River valley roosted within small home ranges and foraged close to their roosting area (within 2 km) during the summer (Pretzlaw *et al.* 2004 *in prep*.). Distances between day-roosts ranged from 6.5 m to 106 m (Lausen 2003, Pretzlaw *et al.* 2004 *in prep*.). Moreover, 64% of recaptured individuals were caught within 50 m of their initial capture locations. Based on the findings of this study, Lausen (2003, p. 14) suggests that w. small-footed bats “show daily and seasonal fidelity to micro-geographic areas of the river valley (*e.g.,* same coulee), and this fidelity also seems to exist from year to year.”

3 WEIDEMEYER’S ADMIRAL BUTTERFLY

3.1 Background

The Weidemeyer’s admiral is a distinctive, large black butterfly with bold white bands on both wings and greyish white markings on the underside of the hind wings (Kondla 2000). This species is widely distributed in the western interior of the United States but is limited in its distribution in Canada. The only known resident population in Canada occurs along an estimated 80 km stretch of the Milk River and its tributaries in southern Alberta (Kondlay 2000). This population is estimated to be between 1800 and 3200 individuals (Kondla 2000). The Weidemeyer’s admiral is listed as “May Be At Risk” in Alberta at the general status level (SRD 2001a). At a national level, this species was designated as a species of “Special Concern” in May 2000 by COSEWIC (COSEWIC 2003b). Species of “Special Concern” refer to those considered particularly sensitive to human activities or natural events.

Weidemeyer’s admiral populations are patchy and discontinuous reflecting the nature of suitable habitat patches (Kondla 2000). Admiral butterflies are naturally limited by factors such as predation, weather events and the availability of suitable habitat. Human-induced limiting factors include recreational or scientific collecting, and habitat destruction due to agriculture or industrial development (Kondla 2000). Overall, these anthropogenic factors are considered to have a minor influence on admiral populations (Kondla 2000). Most admiral habitat patches are not suitable for mechanized agricultural tillage while developments such as pipeline construction usually only affect small habitat patches (Kondla 2000). Intense livestock grazing in admiral habitats is considered among the more significant anthropogenic threats due to the potential for more widespread impacts (Kondla 2000). Intense livestock grazing can degrade the quality of admiral butterfly habitat in riparian forests and coulee bottoms (SRD 2001a).

3.2 Ecology

Little published information is available regarding the biology of the Weidemeyer's admiral (Kondla 2000). In Alberta, adult admirals have only one flight period per year, from mid-June to mid-July (Kondla 2000). Males are thought to be territorial as they participate in perching and patrolling types of mate-locating behavior as well as contest fighting (Rosenberg and Enquist 1991, Kondla 2000). Males are usually more visible than females which spend most of their time in shrubs (Kondla 2000). Females lay grayish-green eggs singly on the upper side of leaf tips of host plants (Kondla 2000). Common host plants include saskatoon (*Amelanchier alnifolia*), aspen (*Populus tremuloides*), willow (*Salix sp*.) and wild cherries (*Prunus sp*.) (Kondla 2000). Admiral caterpillars feed on the leaves of these plants prior to hibernating through the winter (Kondla 2000). Adults emerge the next summer following pupation, mainly in mid to late June, with some surviving until August (Acorn 1993).

Weidemeyer's admiral hybrids can occur with other admiral species or sub-species where their ranges meet (Kondla 2000). It is believed there is extensive genetic exchange between populations in Canada and the United States (Kondla 2000).

3.2.1 Diet

Admiral caterpillars feed on the leaves of deciduous tree and shrub host plants as described previously. Adult butterflies feed mainly on tree sap, flower nectar (*e.g.,* western clematis (*Clematis ligusticifolia*)) and carrion (Kondla 2000). Moisture is obtained from mud.

3.2.2 Predators

Butterflies fall prey to numerous predators such as birds, other insects and spiders (Acorn 1993).

3.3 Habitat Requirements

3.3.1 General

Weidemeyer's admirals are associated with shrub complexes and woody riparian vegetation along the valleys of the Milk River and its tributaries, including spring or seepage sites and coulee valleys (Kondla 2000). Deciduous trees and shrubby areas provide the necessary habitat components required by this species. Required habitat elements include: larval host plants, moisture and nectar sources for adults and elevated perches for mate-location (Kondla 2000). Within the Milk River drainage, adult Weidemeyer's admirals have been found in association with cottonwoods (*Populus deltoides* and hybrids), saskatoon, western clematis and thorny buffaloberry (*Sheperdia argentea*) (Pike 1987). Admirals were largely absent from large stands or thickets of willow (*Salix* spp.) (Pike 1987).

A habitat suitability index (HSI) model for the Weidemeyer's admiral was developed to indicate potential habitat for this species in the Milk River Basin (Taylor 2004). Topography and shrub cover were selected as habitat variables since Weidemeyer's admirals are limited to valleys, as well as to areas where shrubs are present. Consequently, the best potential habitat for these butterflies is in the valley shrub complexes along tributaries to the Milk River, where there have been known occurrences of this species.

3.3.2 Area Requirements

Movement patterns and area requirements of Weidemeyer's admirals have not been studied.

4 GRAZING AND W. SMALL-FOOTED BATS AND WEIDEMEYER'S ADMIRAL BUTTERFLIES

Few studies have assessed the potential impacts of livestock grazing on the w. small-footed bat or the Weidemeyer's admiral butterfly. A brief overview of the potential implications of grazing on bats and butterflies and their habitats will be provided here; however, due to the limited information available, a comparative table of various grazing systems will not be given.

As w. small-footed bat roosts are often located in poorly vegetated, steep or slippery, mudstone / sandstone slopes or rock outcroppings along valleys, these sites are typically either inaccessible or unfavourable to livestock (Lausen 2003, Lausen pers. comm.). Therefore, although small-footed bat roosts can be low to the ground (Lausen 2003), livestock trampling of roosts is considered a minor concern (Lausen pers. comm.). Trampling risks may be higher in small pastures where livestock are forced to travel along mudstone / sandstone slopes in order to access water (Lausen pers. comm.). Overall, livestock are far more likely to impact bat foraging habitat around riparian trees and springs (Holloway and Barclay 2000, Lausen pers. comm.). Similarly, intense livestock grazing in woody riparian sites along valleys can negatively impact suitable admiral butterfly habitat (Kondla 2000). Intense trampling and browsing may degrade admiral habitat by reducing the quantity and quality of larval host plants or nectar sources (Kondla 2000). Heavy use may also have direct impacts on admirals such as dislodging larvae from host plants and causing incidental mortality of immature stages due to browsing of host plants (Kondla 2000). Consequently, livestock use in riparian valley habitats may need to be managed and monitored to maintain the quality of these sites for both admiral butterflies and small-footed bats (Holloway and Barclay 2000).

Unlike bison, cattle tend to concentrate their grazing activities in and around riparian areas as opposed to upland grasslands (Knapp *et al.* 1999, Strand and Merritt 1999). This has the potential to exert a continuous disturbance on riparian areas, particularly under season-long grazing systems and heavy stocking rates. Overuse of riparian areas can result in denudation of bank vegetation, increased erosion and siltation of waterbodies (Strand and Merritt 1999).

Moreover, excessive excrement deposition in watercourses can lead to eutrophication, algal mat formation, bacterial pollution or acute toxicity of sensitive invertebrates (Strand and Merritt 1999). These effects can negatively impact aquatic insect populations, possibly reducing the availability or diversity of bat prey items (Strand and Merritt 1999). For example, persistent, heavy siltation can result in biomass declines and permanent changes in insect communities, whereby species that require silt-free substrate surfaces are replaced by burrowing invertebrate taxa (Strand and Merritt 1999). In addition, removal or reduction of woody riparian vegetation due to excessive browsing or trampling may adversely affect aerial insects by eliminating, cool, shaded resting substrates or food sources (Strand and Merritt 1999). Elimination of deep rooted woody vegetation can also lead to increased erosion and bank slumping which can eventually alter channel morphology and lead to increased velocity of streams and rivers (Fitch and Adams 1998). Bats tend to prefer foraging directly over waterbodies with slower currents, where they are capable of trawling insects directly from the water's surface (Holloway and Barclay 2000). Increased water velocity may also alter aquatic invertebrate communities by affecting their foraging or breeding microhabitats.

5 GRAZING SYSTEMS AND W. SMALL-FOOTED BAT AND WEIDEMEYER'S ADMIRAL HABITAT MANAGEMENT

Various grazing management strategies have been suggested to maintain or improve the health of riparian areas (Fitch and Adams 1998). A key consideration is to protect riparian areas from grazing during vulnerable periods, such as in the spring when banks are saturated and easily damaged, or in the fall when woody species are most vulnerable to browsing (Fitch and Adams 1998). Other considerations are ensuring appropriate levels of vegetation utilization (between 25% to 65%) and using distribution tools such as off-stream watering and salt placement (Fitch and Adams 1998). Deferred or rest-rotation grazing systems are generally preferred over season-long or continuous grazing, particularly in complex landscapes with well-developed riparian areas (Fitch and Adams 1998). Under rest-rotation grazing, grazing is rotated between multiple pasture units with at least one pasture receiving a full year's rest in a grazing cycle (Fitch and Adams 1998). Allowing areas to be rested helps to maintain woody species and restore fragile stream banks. For example, a known admiral butterfly host plant, saskatoon, is considered a highly preferred browse species for livestock and wild ungulates and will decrease under persistent heavy utilization (Thompson and Hanson 2001). Providing periods of rest will help to maintain healthy saskatoon communities, as this species is known to repopulate sites where it was previously severely reduced (Thompson and Hanson 2001). Similarly, periodic rest is necessary to maintain healthy cottonwood stands (Fitch and Adams 1998). Heavy browsing and trampling by cattle is known to negatively affect cottonwood regeneration and density along the Milk River (Bradley and Smith 1986). Where necessary, fencing may be required to allow the recovery of riparian vegetation in frequently, heavily used areas (Fitch and Adams 1998).

6 BENEFICIAL MANAGEMENT PRACTICE RECOMMENDATIONS

Overall, w. small-footed bats in the Milk River Basin are potentially limited by the availability of suitable roosting, hibernating and foraging areas, as well as proximity to water. Management practices that limit disturbance to roosts or potentially suitable hibernacula and that maintain or restore the productivity of riparian foraging habitats, will be of benefit to this species (Holloway and Barclay 2000). Maintaining healthy riparian habitats for bats will also help to retain key habitats for Weidemeyer's admirals that are thought to be entirely reliant on shrubby or deciduous draws (Kondla 2000).

The following general land use and grazing recommendations provide a variety of means by which to protect or enhance w. small-footed bat and Weidemeyer's admiral habitats. These recommendations apply to the range of these species within the Milk River basin and throughout the Grassland Natural Region of Alberta. Further research is required (Section 7) to improve our understanding of these species in order to evaluate or refine appropriate management recommendations.

6.1.1 General Recommendations

- Avoid water diversion projects or the creation of new dams or reservoirs along prairie river valleys and drainages within the Milk River Basin (Lausen 2003). Flooding from the creation of large reservoirs can eliminate suitable habitat for both Weidemeyer's admirals and w. small-footed bats. As river valley habitats are critical to these species, this can have potentially severe consequences for both species. Pretzlaw *et al.* (2004 in prep.) list dam developments as the single largest threat to w. small-footed bats in southern Alberta. Damming or water diversion can also negatively affect riparian vegetation communities such as cottonwood forests by impeding seedling establishment (Bradley and Smith 1986). Cottonwoods are reliant on periodic flooding during periods of seed dispersal to provide suitable conditions for seedling establishment (Bradley and Smith 1986). Riparian cottonwood forests and associated plant communities, as discussed, provide important foraging habitats for w. small-footed bats and provide the required habitat components for Weidemeyer's admirals in the Milk River Basin (Pike 1987, Holloway and Barclay 2000). Cottonwood forests also provide habitat to numerous other wildlife species including providing important summer roosting sites for hoary (*Lasiurus cinereus*), red (*L. borealis*) and silver-haired bats (*Lasionycteris noctivagans*) (Barclay 1993).
- Protect natural w. small-footed bat roosts and hibernacula from recreational (*e.g.,* off-road vehicle use), industrial or other types of human disturbance (Brigham 1993, Schmidt 2003). As suitable roosting sites are limited in prairie landscapes, and as bats may hibernate in large groups, destruction of roosts may significantly negatively impact bat populations (Chung-MacCoubrey 1996). Unless disturbed, bats tend to show a strong degree of fidelity to summer and winter roosting sites (Brigham 1993, Lausen 2003). Disturbing bats during hibernation can be particularly harmful as it can severely drain critical fat reserves bats depend on to survive until the following spring (Brigham 1993). When disturbed during hibernation, bats require up to an hour to arouse and are therefore especially vulnerable to disturbance (Brigham 1993).

- The Milk River Basin HSI maps developed for the w. small-footed bat (Landry 2004) and Weidemeyer's admiral (Taylor 2004) should be used to inform environmental planning of development activities to ensure key habitats are avoided wherever possible. The HSI maps should be revised as additional information or refined GIS data layers become available.
- At present there are no timing or setback guidelines for industrial development activities from known small-footed bat roosts or critical Weidemeyer's admiral habitats (SRD 2001b). To avoid disturbing small-footed bats during lactation, development activities should be restricted between mid-June to the end of July (Lausen pers. comm.). W. small-footed bats are more dispersed from May to mid-June prior to becoming established in their maternity areas (Lausen pers. comm.). Bats disperse again once pups begin to fly at the beginning of August (Lausen pers. comm.). Development activities from November to March pose a risk to hibernating bats. More research is needed to locate and characterize w. small-footed bat hibernacula in the Milk River Basin.
- Maintain or restore the quality of riparian areas and springs used by bats during foraging and that provide key habitat for Weidemeyer's admiral butterflies (Holloway and Barclay 2000). Bats may forage up to 2 km from suitable roosting sites (Holloway 1998).
- Avoid the use of pesticides or herbicides near drainages used by w. small-footed bats or Weidemeyer's admirals. The use of these chemicals may have direct adverse effects on admirals and may reduce aquatic insect populations that are an important food source for bats (Forsyth 1993, 1996, Holloway and Barclay 2000).
- Promote bats as pest-control agents. Bats are capable of consuming 50% to 100% of their own mass in insects per night (Barclay 1993, Brigham 1993). For example, for the little brown myotis (M. lucifugus) this amounts to approximately 400 mosquito-sized insects (Barclay 1993). Lactating bats have even higher energy demands.

6.1.2 Grazing Recommendations

As livestock are unlikely to directly impact bat roost sites, management efforts should aim to mitigate potential livestock impact to bat foraging grounds. Maintaining healthy riparian habitats is important to provide bats with productive foraging sites (Holloway and Barclay 2000). Healthy riparian sites with a diverse shrub and forb community also provide key habitat for Weidemeyer's admirals. The timing and intensity of grazing, the ability to control animal distribution and access to water, and the frequency and duration of rest periods effect how severely cattle impact riparian habitats (Fitch and Adams 1998). Appropriate grazing systems should be developed site specifically for participating ranches as part of the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

The following recommendations consider grazing management practices that can be used to improve the quality of riparian habitats for w. small-footed bats and Weidemeyer's admirals.

- Observe conservative utilization rates (25% to 65%) in riparian areas to maintain vigorous herbaceous and woody vegetation (Fitch and Adams 1998).

- Place salt or mineral sources at least 1 km from natural water bodies, where possible (Adams *et al.* 1986). Placing salt away from water forces cattle to make better use of the range and reduces the amount of time cattle spend at water sources.
- Provide alternate watering sites (*e.g.,* dugouts or troughs) to reduce impact to natural riparian habitats. Cattle have been shown to prefer drinking from a water trough and will travel further to a trough rather than drink from a stream when given free access to both (Veira 2003). Off-site watering can provide a more reliable and cleaner water source for cattle and creates additional water sources for bats in an arid landscape. Improved water quality can improve livestock health and weight gain (Veira 2003).
- Off site watering systems and salt placement are particularly effective tools in relatively flat prairie, however, in variable terrain, additional methods (as described below) may be required to improve cattle distribution and minimize impact to riparian habitats.
- Provide graveled or hardened access points for livestock at select points along a stream or river away from productive bat foraging habitat or critical Weidemeyer's admiral habitat. This focuses cattle use at predetermined locations and reduces sedimentation of watercourses.
- Use rest or deferred rotation grazing systems to ensure sufficient periods of rest and recovery in riparian areas (Fitch and Adams 1998). Providing periods of rest allows for the recovery of woody species that may be important host plants for admiral butterflies. Periodic rest also reduces potential incidental mortality of butterfly larvae due to trampling or browsing. Several years of rest may be required where the goal is to regenerate new trees like cottonwoods (Fitch and Adams 1998).
- Defer use near riparian areas during vulnerable periods such as in the spring when stream banks are saturated and are susceptible to slumping and erosion. Also, avoid heavy use of riparian areas in the fall when woody vegetation is most vulnerable to browsing (Fitch and Adams 1998).
- In areas with distinct upland and lowland areas, explore the use of riparian pastures to defer use in riparian areas during the spring. Riparian pastures are created by fencing upland terrain and riparian landscape units separately (Fitch and Adams 1998).
- Where necessary, fence out select riparian areas to restore water quality or vegetation cover or to prevent damage at key times of the year (*i.e.,* during spring and fall).

7 RESEARCH RECOMMENDATIONS

There is limited information available about the population status or ecology of w. small-footed bats and Weidemeyer's admirals in southern Alberta (Barclay 1993, Kondla 2000). Further research is also needed to better evaluate the impact of land use activities on these species in the Milk River Basin.

Several key research recommendations for each species are given below:

7.1 Western Small-footed Bat

- Develop a long-term monitoring strategy to assess changes in the distribution and abundance of w. small-footed bats within the Milk River Basin;
- Assess the vulnerability of traditional, natural roosts from livestock or human disturbance;
- Study w. small-footed bat movement patterns and seasonal habitat use;
- Investigate the winter behaviour and determine the distribution and characteristics of w. small-footed bat hibernacula within the Milk River Basin. To locate hibernation areas, bat activity will need to be persistently monitored along river valleys in the late fall and during Chinook periods in the winter months (Lausen 2003);
- Map out and characterize important linkage habitats (*i.e.,* dispersal corridors) between summer and winter ranges;
- Assess the impact of pesticide and herbicide use on bat prey densities in key foraging habitats;
- Evaluate the effects of grazing in riparian areas on the abundance or diversity of insect prey. For example, compare bat prey density and composition along a gradient of unhealthy to healthy riparian habitats where livestock grazing is the primary determinant of riparian health; and
- Compare bat abundance and behaviour before and after implementation of various human activities such as implementation of a new grazing regime, increased recreational use, or industrial developments (Chung-MacCoubrey 1996).

7.2 Weidemeyer's Admiral Butterfly

- Investigate the possibility of conducting mark-release-recapture studies or transect counts to monitor Weidemeyer's admiral population abundance and trends in the Milk River basin (Kondla 2000);
- More information is needed regarding Weidemeyer's admiral biology, habitat use and seasonal movements;
- Determine specific host or nectar plant species associations;
- Determine the forage value or susceptibility of host or nectar plants to livestock versus wild ungulate herbivory;
- Assess the effectiveness of suggested riparian area grazing strategies for maintaining or improving the quality of Weidemeyer's admiral habitats; and
- Evaluate the most appropriate timing and frequency of livestock grazing to minimize potential for incidental mortality of butterfly larvae and to sustain healthy communities of host or nectar plants.

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SYNTHESIS

1 BENEFICIAL MANAGEMENT PRACTICES SYNTHESIS

Part III of this report provides an overview of the ecological and habitat requirements for 28 select management species within the Milk River Basin. Beneficial management practices are presented for individual species or species groups. This information is intended to assist with the design of appropriate stewardship activities under the Multi-Species Conservation Strategy for Species At Risk in the Milk River Basin (MULTISAR).

There are several key recommendations that are repeatedly stressed for the majority of species and species groups. Of prime importance is the need for the retention, protection, and maintenance of large, contiguous blocks of native prairie and unique landscape features or habitat types such as sand hills, badlands, river valleys and riparian areas. Conservation of natural corridors linking native prairie, wetland or unique landscape features is also important to facilitate dispersal and connectivity between wildlife populations. Maintaining the integrity of native habitats requires minimizing the potential effects of development or high-impact human activities, and avoiding loss of habitat due to cultivation or encroachment of exotic invasive species. Another important consideration is the maintenance and management of key natural disturbance processes such as grazing within native habitats.

1.1 Key Land Use Recommendations

Cultivation, industrial or commercial development, road construction and water diversion projects have the greatest potential to fragment or remove valued habitats or critical habitat components for select management species. Undertaking pre-development environmental planning, applying minimal disturbance construction techniques, and observing timing and setback restrictions near important wildlife habitats can minimize impacts from industrial development. Complete exclusion of certain critical wildlife areas from industrial disturbance is also necessary, especially considering the cumulative impact of development activities and associated infrastructure. The value of existing cropland areas within the Milk River Basin to wildlife species can be improved by careful attention to appropriate farming practices, such as minimum or zero tillage, delayed summer haying (to avoid the nesting season), and the use of organic farming techniques. Organic farming practices have numerous benefits for wildlife and for maintaining healthy ecosystems. Organic farming promotes the use of natural biological control methods for pest management as well as the use of natural versus synthetic fertilizers. Crop rotations, crop residues, animal manures, legumes and green manures and mechanical cultivation are used in organic farming as alternative methods to maintain soil fertility and productivity. In this way, organic farming emphasizes management procedures that work with natural cycles and processes to conserve beneficial soil organisms and natural pest controls. Multiple crop systems and avoidance of pesticide use creates increased diversity in vegetation structure and food items available to wildlife and may help to improve water quality in local watersheds. The use of pesticides or herbicides, organo-chlorine compounds in particular, has the potential to diminish food supplies for wildlife and can cause direct toxicity or reduced survival or reproductive success. Toxins are often passed through the food chain to higher order predators through the processes of bioconcentration, bioaccumulation and biomagnification. Moreover, many insect or rodent species targeted by pesticide campaigns play a vital ecological role as important prey species. Rodent “pests” such as the Richardson’s ground squirrel have ecological importance not only as a crucial prey source but also for providing habitat for numerous wildlife species through its burrowing activities. Promoting predators as natural control agents and appropriate grassland management can be used as alternative methods of controlling ground squirrels within tolerable thresholds.

1.2 Important Grazing Management Principles and Recommendations

1.2.1 Maintaining a Range of Natural Variation

Livestock grazing can provide an economical and sustainable use of the landscape while allowing for the conservation of natural landscapes and native prairie. Grazing by herds of large ungulates in combination with fire and drought cycles are natural processes that shaped the evolution of prairie ecosystems for thousands of years. Bison were a keystone species of the North American Great Plains. Livestock replaced bison as the dominant grazers in southern Alberta by the late 1800's. Grazing by large ungulates has the potential to modify the composition and structure of plant communities. This has an indirect or direct influence on various wildlife species through affects on food sources or habitat quality. If appropriately managed, grazing can be used to enhance, maintain or create habitat for multiple species. In this respect, it is important to remember that certain rare, unique, threatened or endangered species occur on rangelands because of, and not in spite of, appropriate historic stewardship practices.

Managing for a "range of variation" in the size, intensity and return interval of disturbance processes is an important concept of prairie ecosystem management (Bradley and Wallis 1996, Adams *et al.* 2004). Prairie fauna and flora are adapted to a variety of cover or disturbance thresholds. For example, although migratory herds of bison may have had significant local impacts, periods of high impact would likely have been offset by periods of rest when local forage or water sources became depleted. Moreover, although some areas may have been subject to frequent bison disturbance, other areas may not have been exposed to bison for several decades (Bradley and Wallis 1996). The impact of bison also fluctuated in response to climate cycles, fires and patterns of forage quantity or quality, creating a range of cover types across the landscape. Wildlife species are consequently adapted to different intensities of grazing. Species such as the mountain plover and Richardson's ground squirrel occur in more heavily grazed grasslands, while others such as Baird's sparrows and Sprague's pipits prefer more lightly grazed areas. Species like the burrowing owl require short vegetation near nest sites, but require taller cover within 600 m of nests to maintain suitable conditions for a stable small mammal prey base. Meadow voles, a key prey item for burrowing owls and short-eared owls typically occur in areas with taller grass cover. Current livestock grazing systems may achieve a range of variation in vegetation cover and create habitat for a diversity of wildlife, if they are tailored to promote an interspersion of heavy, moderate and lightly grazed patches. The use of multiple grazing systems over the landscape, as opposed to a single system, is also beneficial for promoting heterogeneous cover types at larger scales. Range management that over-intensifies or homogenizes grazing across the landscape will tend to reduce the range of natural variation (Bradley and Wallis 1996).

1.2.2 Adaptive Management

To maximize the benefits to wildlife and the ecology of an area, grazing management must be flexible and custom tailored to meet the needs and character of each management unit. For example, several grazing systems can be applied on a single ranching operation to take advantage of topographic features, multiple types of native range or the availability of seeded pasture that may exist in an area. Designing an appropriate grazing management system, therefore, is ultimately dependent on local conditions and economic considerations balanced with other resource management needs and objectives (Adams *et al.* 2004). There is no universal 'best' grazing system that can be applied in all cases. The success of a grazing system depends on appropriate stocking rates, animal distribution, proper use, and monitoring. Grazing systems need to be considered as part of an adaptive approach to landscape management to react to changes in climate, management priorities or resource conditions. An adaptive management approach involves goal setting, implementation of a planned strategy, and continual monitoring and adjustment. Before any type of management system can be implemented, the objectives of the ranching operation and wildlife habitat requirements should first be defined. Secondly, knowledge of the range resource base should be obtained (*e.g.,* present range condition or health and distribution of critical wildlife habitat features). Landowner support and commitment to the implementation of a habitat conservation strategy is the overriding factor to its success.

1.2.3 Grazing Management Tools and Principles

Beneficial livestock grazing practices consider grazing capacities and stocking rates (or grazing intensity), timing (*i.e.,* onset and duration) and frequency of grazing, distribution practices, the application of appropriate grazing systems, as well as specialized grazing practices (Adams *et al.* 2004). Of these factors, grazing intensity can often be a decisive factor in terms of potential impacts to wildlife. Grazing intensity affects the amount of forage biomass removed by livestock and the amount of residual cover that remains. This has an effect on forage resources and on the availability of nesting, predator escape or thermal cover available to wildlife. Grazing capacities and stocking rates also affects the degree of impact livestock have on riparian habitats. As discussed below, riparian areas provide important habitat for a diversity of wildlife. Range condition (or range health), wildlife management priorities, forage productivity and the contribution of wild native grazers need to be considered when establishing appropriate grazing capacities. Moderate grazing intensity is generally considered beneficial to most wildlife species as it allows for a gradation of use across pastures, and promotes the formation of overgrazed and undergrazed patches. Patch grazing contributes to landscape heterogeneity. Grazing systems can be used to create planned heterogeneity on a larger scale by controlling grazing pressure and timing within multiple fields. Controlling livestock distribution through the use of herding, salt or upland water placement is another mechanism to create planned heterogeneous use across the landscape. The class and age of livestock are other considerations with respect to improving livestock distribution. Most distribution tools work best in conjunction with grazing systems. Without effective livestock distribution, grazing is usually restricted to preferred areas. This not only has implications to wildlife habitat but it also reduces the effective grazeable land area and consequently leads to reduced stocking rates. Concentration of grazing in preferred areas may also lead to other range management concerns such as exotic or weed species encroachment and soil erosion.

Livestock distribution, timing and frequency can be designed not only to promote heterogeneity but can also be coordinated with the life histories of select management species to avoid critical habitats during sensitive periods. For example, deferring grazing during the spring near sharp-tailed grouse leks minimizes the risk of trampling nests and eggs and avoids the removal of critical nesting or brood rearing vegetation cover. Spring deferral has the added advantage of avoiding grazing during vulnerable growth phases of native plants and allows for improved seed production, seedling establishment and restored plant vigour. Deferral is usually recommended until after May 15 through to June 15. Spring deferral requires the use of complementary grazing or deferred rotation grazing. Complementary grazing involves the use of seeded pasture early in the season. As conservation of native prairie is pivotal, this strategy is only recommended where seeded pasture already exist within the grazing operation. Under deferred rotation grazing, spring use is alternated between multiple pastures from year to year.

To minimize potential impacts to wildlife, it is important to carefully plan the distribution of high use points associated with water or salting facilities, fences, corrals or winter feeding stations in relation to critical habitat components. These facilities should be set back from critical features such as leks, hibernacula, traditional nesting sites or key winter ranges. Fences and watering and livestock handling facilities not only concentrate livestock use, they also provide perches for avian predators and potentially serve as sources for invasion of exotic species.

1.2.4 Riparian Area Management

Although factors such as vegetation type, soils, slopes, terrain, insects and weather influence livestock distribution over the landscape, water is ultimately the most influential factor, particularly in semi-arid environments. Unlike bison, cattle tend to linger for longer periods near water sources and tend not to travel as far from water. Consequently, cattle can have significant impacts to natural floodplain and riparian habitats (*i.e.,* habitats associated with the margin of wetlands, streams or rivers). The impacts of cattle on ephemeral wetlands and riparian habitats can influence numerous wildlife species including northern leopard frogs, plains spadefoot and great plains toads, sharp-tailed grouse, loggerhead shrikes, ferruginous hawks, golden eagles, Swainson’s hawks, western small-footed bats, Weidemeyer’s admiral butterflies, mule deer and white-tailed deer. The structural complexity and plant species diversity associated with riparian habitats provides thermal or escape cover, forage, or nesting material for these species. Overuse of riparian areas due to heavy trampling or browsing can result in denudation of bank vegetation, increased erosion and siltation of waterbodies with negative consequences to wildlife.

Several strategies have been proposed to manage the use of livestock in riparian areas, while maintaining their structure and function (*i.e.,* their health) (Fitch and Adams 1998). A key consideration is to protect riparian areas from grazing during vulnerable periods, such as in the spring when banks are saturated and easily damaged, or in the fall when woody species are most vulnerable to browsing. Other considerations include ensuring appropriate levels of vegetation utilization (between 25% to 65%) and using distribution tools such as off-stream watering and salt placement. Deferred or rest-rotation grazing systems are generally preferred over season-long or continuous grazing to provide periods of rest. Under rest-rotation grazing, grazing is rotated between multiple pasture units with at least one pasture receiving a full year of rest in a grazing cycle. Allowing areas to be rested helps to maintain woody species and restore fragile stream banks. Where necessary, fencing may be required to allow the recovery of riparian vegetation in frequently, heavily used areas. This may help to prevent the loss of important nest trees or critical Weidemeyer's admiral butterfly habitat. Temporary fencing can also be used to exclude cattle from critical northern leopard frog, plains spadefoot or great plains toad breeding ponds during the spring.

1.3 Burning or Mowing

Prescribed burning and mowing are other tools that have been suggested to mimic natural disturbance processes and maintain or enhance habitat for wildlife such as grassland birds. The application of these tools is contingent on further research as well as on buy-in and acceptance from landowners. Further research is needed to investigate historic fire return intervals and the potential impacts of mowing or burn treatments on plant community composition, structure and wildlife habitat. Mowing and burning are typically suggested as tools to control shrub or woody species encroachment or to reduce accumulations of dense litter. Their application is generally better suited to areas with higher moisture and greater grassland productivity. It is important to consider the timing, spatial extent and distribution and frequency of burning and mowing applications. To minimize their potential impacts to ground nesting birds, mowing or burn treatments should not be conducted during the peak nesting season (from May 1 to the end of July).

1.4 Summary Tables

The following tables are intended to provide an overview and quick reference to summarize the information presented in Part III of this report. Table S-1 provides a summary of habitat associations, key prey and timing considerations for the 28 species considered in this report. Tables S-2 and S-3 provide an overview of key beneficial management practices for the Milk River Basin.

Table S-1 Summary of Habitat Associations, Key Prey and Timing Considerations for 28 Select Management Species in the Milk River Basin

Species	Status in Alberta	Habitat Type	Key Features (B = Breeding habitat; F= Foraging habitat; W= Over-wintering habitat)	HSI Variables	Key Prey (if applicable)	Timing Considerations (B= Breeding period; W=Winter range / hibernacula use)
Birds						
Ferruginous hawk	At Risk	River valley / native prairie / riparian habitats	B: Cliff and hoodoo nest sites along the Milk River and tributaries / tree nests / native prairie ground nests F: Native prairie with Richardson's ground squirrels	1. Native prairie 2. Moderately coarse soil texture	Richardson's ground squirrel	B: March 15- July 15
Swainson's hawk	Sensitive	Native prairie / seeded pasture / riparian habitats	B: Trees/ shelterbelt nest sites / native prairie ground nests F: Native prairie with Richardson's ground squirrels and interspersed taller grasslands	N/A	Richardson's ground squirrel	B: March 15- July 15
Golden eagle	Sensitive	River valley / native prairie	B: Cliff and hoodoo nest sites along the Milk river and tributaries F: Shrubby, sagebrush or edge habitats	N/A	White-tailed jackrabbit, mountain cottontail	B: March 15- July 15
Short-eared owl	May Be At Risk	Native prairie/ seeded pasture	B: Ground nests in ungrazed / lightly grazed grasslands F: Meadow vole habitat (taller grasslands)	N/A	Meadow vole	B: April 1 – July 31
Prairie falcon	Sensitive	River valley / native prairie	B: Cliff and hoodoo nest sites along the Milk river and tributaries F: Native prairie with Richardson's ground squirrels within 15 km of nest sites	1. Slopes greater than 75 degrees 2. Richardson's ground squirrel habitat suitability 3. Distance to ground squirrel habitat (15 km from nests)	Richardson's ground squirrel	B: March 15- July 15
Sharp-tailed grouse	Sensitive	Native prairie and riparian habitats	B: Uses native prairie with raised or flat areas of shorter cover for leks and nests in surrounding taller grass or shrub patches W: Aspen bluffs and shrubby or riparian hardwood draws	1. Native prairie 2. 5% to 15% shrub cover	N/A	B: March 15 – July 15
Mountain plover	Sensitive	Lost River and Wildhorse breeding sites	B+F: Ground nests in short vegetation (less than 10 cm in height), between 30% to 50% bare ground and in areas with 0.5 km to 1 km diameter of flat terrain. Heavily grazed / recently burned areas preferred.	N/A	N/A	B: April - July

Species	Status in Alberta	Habitat Type	Key Features (B = Breeding habitat; F= Foraging habitat; W= Over-wintering habitat)	HSI Variables	Key Prey (if applicable)	Timing Considerations (B= Breeding period; W=Winter range / hibernacula use)
Birds Cont'd.						
Burrowing owl	At Risk	Dry Mixedgrass / Mixedgrass prairie	B: Uses Richardson's ground squirrel or badger burrows with surrounding short vegetation for nesting F: Taller grassland cover (~30 cm to 60 cm) within 600 m of nests; wetland and riparian areas may be important	1. Native prairie 2. Moderate to moderately coarse soil texture 3. 0% shrub / tree cover 4. Distance to linear disturbance (> 800m)	Deer mouse and meadow vole	B: April – August 15
Loggerhead shrike	Sensitive	Native prairie / seeded pasture with shrubs or shelterbelts	B: Shrubs and shelterbelts used for nesting F: >20 cm tall grass cover, available tall shrubs or fences for perching and edge habitat	1. 5% to 15% shrub cover 2. > 80% grass cover 3. Flat terrain 4. Farmyards	N/A	B: May 1 – July1
Long-billed curlew	May Be At Risk	Native prairie	B: Nests in short (10 cm to 20 cm) grasslands, in flat to rolling topography; taller vegetation is used for brood rearing. Avoids areas with high shrub density. F: Short (10 cm to 20 cm) grasslands	N/A	N/A	B: April 15 – July 15
Upland sandpiper	Sensitive	Native prairie / seeded pasture	B: Nests in taller grassland cover (10 cm to 64 cm) and uses short to intermediate grasslands for brood rearing (less than 15 cm). Prefers low to moderate forb cover and little woody vegetation cover. F: Uses shorter grass cover for foraging	N/A	N/A	B: May 15 – July 31
Sprague's pipit	Sensitive	Native prairie	B+F: Native prairie; intermediate grass heights (~28 cm max), litter depths 1.2 cm – 3 cm, moderate to high grass to forb ratios, low shrub cover	1. Native prairie (>25%) 2. Less than 15% shrub cover 3. Distance from riparian areas	N/A	B: April 15 – July 15
Baird's sparrow	Sensitive	Native prairie / narrow-leaved seeded pasture	B+F: Native or narrow-leaved exotic grassland; less than 20% shrub cover, litter depths of 0.1 cm to 4 cm and average grass heights of 10 cm to 30 cm	N/A	N/A	B: May 15 – July 15
Mammals						
Olive-backed pocket mouse	Sensitive	Sand hills / sandy range sites	B+F: Grasslands with loose sandy soils, and short or sparse vegetation, low shrub density	1. Grassland habitats 2. Moderate, moderately coarse or coarse soil texture 3. 10% to 30% bare ground 4. 60% to 80% graminoids 5. 5% to 10% shrub cover	N/A	B: late April - June W: October 15 – April
Swift fox	At Risk	Dry Mixedgrass / Mixedgrass prairie	B: Badger burrows, short vegetation, flat to rolling terrain F: Patchy vegetation (short – intermediate cover)	N/A	Voles are an important winter prey source	B: late January breed; pups produced late April – early May

Species	Status in Alberta	Habitat Type	Key Features (B = Breeding habitat; F= Foraging habitat; W= Over-wintering habitat)	HSI Variables	Key Prey (if applicable)	Timing Considerations (B= Breeding period; W=Winter range / hibernacula use)
Mammals Cont'd.						
American badger	Sensitive	Native prairie / seeded pasture	B: Open grasslands, friable soils, little woody cover F: Habitats with high concentration of Richardson's ground squirrels / northern pocket gophers	1. Moderately coarse, medium and moderately fine soil texture 2. Greater than 70% graminoid cover 3. 0 to 15 degree slopes 4. >400 m from roadways	Richardson's ground squirrel, northern pocket gopher	B: Birthing occurs between April - June
Richardson's ground squirrel	Secure	Native prairie / suitably grazed seeded pasture	B+F: Short grassland vegetation (less than 5 cm) and moderately well drained soils	1. >20% grass cover 2. 0 to 10 degree slopes 3. Moderately coarse or medium soil texture	N/A	B: March – April; juveniles emerge aboveground in May W: Hibernate for 4 to 8 months beginning in mid-June (adult males), July (adult females), or August – October (juveniles)
Mule deer	Secure	Native prairie / seeded pasture / riparian habitats	B: Dense shrub cover (*e.g.,* deciduous thickets) F: Rugged, open terrain, grass / forb / shrub interface W: South and west facing, wind swept grassy slopes along coulee breaks and slopes / shelterbelts / aspen groves	N/A	N/A	B: Rutting: Late October – early December; Fawning: May – early June W: Winter range is used when snow depths exceed ~20 cm
White-tailed deer	Secure	Primarily riparian habitats	B: Woody draws, drainages, and basins with slopes of less than 15% F: Riparian habitats W: South and west facing, wind swept grassy slopes along river valleys / shelterbelts / aspen groves	N/A	N/A	B: Rutting: Late October – early December; Fawning: May – early June W: Winter range is used when snow depths exceed ~20 cm
Western-small footed bat	Sensitive	River valley	B: River valleys or coulees with sandstone cliffs, rocky outcrops or eroded mudstone slopes F: Cottonwood riparian forests	1. Shallow to bedrock soils 2. Slopes greater than 10 degrees 3. Less than 1 km	N/A	B: Lactation – June 15 – July 31

Species	Status in Alberta	Habitat Type	Key Features (B = Breeding habitat; F= Foraging habitat; W= Over-wintering habitat)	HSI Variables	Key Prey (if applicable)	Timing Considerations (B= Breeding period; W=Winter range / hibernacula use)
Reptiles and Amphibians						
Prairie rattlesnake	May Be At Risk	River valley, coulee or drainage; south / east / southeast slopes	B: Breeds within 5 km of major drainages. South / east / southeast aspect are usually selected. Mammal burrows, flat rocks and moderate shrub cover are important habitat components. F: Native prairie within 25 km of major drainage W: Hibernacula found along river escarpments with stable slump blocks, meander scars and fissures, subterranean water channels, sinkholes, and rocky outcrops. Badger burrows are often selected for. Hibernacula are usually located on south / east / southeast aspects.	*Hibernacula (Wintering Habitat):* 1. <4 km from major river, coulee or drainage 2. South, east, or southeast slopes 3. Rough terrain (high relief, moderate to steep slopes, >10% exposed bedrock) *Summer Habitat:* 1. <25 km from major river, coulee or drainage 2. Low densities of major roadways 3. Native prairie cover 4. Low to moderate shrub density *Birthing Sites (Rookery):* 1. 1 km to 5 km from major river, coulee and drainage 2. South, east, southeast aspect 3. Moderate shrub cover 4. Moderate bare rock cover	Generalist diet; Small mammals important (voles / northern pocket gopher / Richardson's ground squirrel)	Active period: late April / early May - mid September Birthing: late August - mid-October
Bullsnake	Sensitive	River valley, coulee or drainage; south /east / southeast slopes	B: Sandy or friable soils; mammal burrows; south / east / southeast aspects along major river, coulee or drainage F: Native prairie within 25 km of major drainage; will forage in riparian forests W: Uses similar hibernacula as prairie rattlesnakes	N/A	Generalist diet; Small mammals important (voles / northern pocket gopher / Richardson's ground squirrel)	Active period: late April / mid-June - late August / mid October Hatching: mid-August - mid-September
Short-horned lizard	May Be At Risk	River valley, coulee or drainage; usually south aspect	B+F: Sparsely vegetated south slopes preferred; some sagebrush cover and mammal burrows provide thermal cover W: Loose soil of south facing slopes	1. <100 m of valleys 2. Native prairie 3. <1,100 m 4. <5% riparian features	Ants	Active period: mid April - mid September Birthing: late July-early August

Species	Status in Alberta	Habitat Type	Key Features (B = Breeding habitat; F= Foraging habitat; W= Over-wintering habitat)	HSI Variables	Key Prey (if applicable)	Timing Considerations (B= Breeding period; W=Winter range / hibernacula use)
Reptiles and Amphibians Cont'd.						
Plains hognose snake	May Be At Risk	Dry Mixedgrass / Mixedgrass prairie	B+F: Native prairie with sandy surficial deposits, sufficient vegetation cover, and with seasonal or permanent wetlands W: Rodent burrows	N/A	Toads	Active period: late April / early May - mid September / early October Egg laying: June 15 – July 31; 60 day incubation period
Great plains toad	May Be At Risk	Ephemeral wetlands; sand hill / sand plain, Dry Mixedgrass / Mixedgrass prairie	B: Ephemeral wetlands, fresh, clear water, in areas of sandy soil F: Native prairie near ephemeral wetlands with sandy / friable soils W: Rodent burrows, friable sandy soils	1. >75% native prairie 2. Chernozemic / solonetzic soil orders 3. Moderately coarse and coarse soil texture	N/A	B: late April – mid June; newly metamorphosed young: late June – mid July
Plains spadefoot toad	May Be At Risk	Ephemeral wetlands	B: Ephemeral wetlands F: Native prairie with sandy soils; ephemeral wetlands W: Friable sandy soils, rodent burrows	1. Moderately coarse and coarse soil texture 2. >75% native prairie	N/A	B: early May – early July; eggs hatch rapidly; tadpoles metamorphose 21-34 days after hatching
Northern leopard frog	At Risk	Permanent wetlands	B: Shallow / warm standing water of permanent water bodies with abundant aquatic and emergent vegetation F: Near water bodies; open areas with intermediate vegetation (avoid heavily grazed / tall, dense vegetation) W: Springs / deep water bodies that do not freeze solid	N/A	N/A	Active period: April – October B: Late April – late June; tadpoles metamorphose in late July / early August
Other						
Weidemeyer's admiral butterfly	May Be At Risk	Milk River valley and tributaries	B+F: Shrub complexes and woody riparian vegetation along the valleys of the Milk River and its tributaries, including spring or seepage sites and coulee valleys	1. Valley topography 2. >10% shrub cover	N/A	Flight period: mid-June to mid-July

Table S-2 Summary of Beneficial Management Practices for the Milk River Basin

GENERAL LAND USE RECOMMENDATIONS

Native Habitat Protection

- Protect large, contiguous blocks of native prairie from cultivation or extensive development. It is preferable to maintain native grassland habitats with high interior area and minimal edge to reduce potential edge and isolation effects (Johnson and Igl 2001). Grassland bird studies have shown that nest predation and nest parasitism rates are higher in small isolated habitat patches or in edge habitats (Johnson and Temple 1990).

- Limit disturbance to unique or rare habitat types such as sand hills / badlands / hoodoos and cliffs along major river valleys such as the North Milk and Milk Rivers.

- Minimize disturbance to sparsely vegetated south, southeast or east facing slopes and slump areas along river valleys and coulees and other major drainages at any time of the year. These areas provide critical overwintering habitat to short-horned lizards, prairie rattlesnakes and bullsnakes.

- Maintain or establish natural corridors between existing native prairie habitats or natural landscape features such as wetlands.

- Minimize the spread of exotic plants (*e.g., s*mooth brome (*Bromus inermis*) or timothy grass (*Phleum pratense*)) in native habitats. The tall or dense growth habits of many herbaceous invasive plants can diminish habitat quality for several wildlife species including mountain plovers, Sprague's pipits, Baird's sparrows, swift fox, Richardson's ground squirrels, prairie rattlesnakes, bullsnakes, hognose snakes, short-horned lizards, spadefoot toads, great plains toads and northern leopard frogs.

- Retain shrubby and woody draw mosaics across the landscape. Shrub patches provide important habitat for loggerhead shrikes, sharp-tailed grouse, white-tailed and mule deer, and for important raptor prey species such as mountain cottontails. Shrubby areas provide these species with breeding, shelter, or foraging habitat. Shrub complexes and woody riparian vegetation along the Milk River and its tributaries are considered critical habitat for Weidemeyer's admiral butterflies and provide important foraging habitat for western small-footed bats.

- Where the goal is to maintain habitat for raptors, maintain individual trees or interspersed tree stands in the landscape and leave dead or decadent trees standing. Monitor the condition of nest trees and where necessary, plant trees or reinforce dead or decadent trees.

- Reclaim and revegetate heavily impacted riparian corridors with native vegetation.

- Where possible, convert non-native uplands (*e.g.,* marginal cropland) to native vegetation or permanent cover.

- Maintain and restore the health of wetland, stream, and riverine riparian habitats. Restore formerly drained wetlands and avoid draining wetlands or converting ephemeral wetlands into permanent water bodies.

- Maintain vegetated buffers around wetlands.

GENERAL RECOMMENDATIONS Continued

Pest Control / Farming Practices

- Promote organic farming practices.
- Consider planting winter wheat as a crop alternative, where feasible. Winter wheat fields require less disturbance during the spring and early summer and thereby minimize possible disturbance to ground nesting birds during the breeding season.
- Promote no-till or minimal tillage and minimize plowing during the spring and early summer nesting season. Zero tillage is beneficial to ground nesting birds.
- Delay haying or harvesting crops until late July or August after the peak nesting period. Use flushing bars during haying to minimize mortality of ground nesting birds.
- Retain shelterbelts around old farmsteads and field edges to provide nesting or cover habitat for raptors, loggerhead shrikes and deer. Consider diversifying shelterbelts by planting native thorny shrubs such as thorny buffaloberry (*Sheperdia argentea*) or hawthorn (*Crataegus* spp.). Where practical, plant multiple, irregular patches of shrubs or trees along shelterbelts to create larger blocks of habitat and reduce the linear nature of shelterbelts.
- Minimize synthetic fertilizer use near drainages and wetlands.
- Avoid the use of organochlorine pesticides including carbamates and organophosphates. These pesticides reduce the diversity and abundance of food sources for wildlife, and may be directly or indirectly toxic or negatively impact reproductive success.
- Discontinue Richardson’s ground squirrel poisoning control programs. Richardson’s ground squirrel populations are an important prey source for ferruginous hawks, Swainson’s hawks, prairie falcons, golden eagles, American badgers, swift fox, rattlesnakes, bullsnakes and hognose snakes. Their burrows also provide important shelter or breeding habitat for burrowing owls, mountain plovers, olive-backed pocket mice, rattlesnakes, bullsnakes, hognose snakes and spadefoot and great plains toads.
- Promote and maintain viable populations of natural predators such as raptors and badgers to provide an alternate method of rodent control.

GENERAL RECOMMENDATIONS Continued

Industrial / Commercial Development / Human Disturbance

- Minimize human disturbance near critical wildlife habitats (leks / nests / dens / breeding ponds / hibernacula / winter range).
- Abide by Alberta Sustainable Resource Development, Fish and Wildlife Division's setbacks and timing restrictions for land use activities or developments near critical wildlife habitats. Constructing during the winter is preferable for most species to avoid disturbance during sensitive breeding periods, provided key winter range or hibernacula are not disturbed.
- Conduct pre-development wildlife surveys and plan developments to avoid sensitive or unique natural habitats where possible.
- Use the Milk River Basin Habitat Suitability Index (HSI) maps and models as a planning tool to avoid sensitive areas and schedule wildlife surveys. Check for HSI model revisions and updates.
- Use appropriate construction methods to minimize development impacts and facilitate reclamation of native habitats.
- Avoid leaving open trenches during the spring and summer months. During construction, routinely check and remove any snakes, amphibians or other wildlife species from trenches.
- Avoid development of water diversion projects such as creation of new dams or reservoirs along prairie rivers and drainages in the Milk River Basin. Altered hydrology impacts floodplain and wetland habitats with negative consequences to numerous species. Localized flooding at dam or reservoir sites can eliminate critical habitat for rare species.

Table S-3 Summary of Beneficial Grazing Practices for the Milk River Basin

GRAZING RECOMMENDATIONS
General Goals
▪ Avoid uniform, heavy grazing across large areas for prolonged periods. Promote patchy grazing to create heterogeneous habitat patches with variable canopy cover, litter (organic residue) and plant species diversity. A mosaic of cover types creates habitat for a wider range of flora and fauna. The desired size or distribution of light, moderate or heavily grazed patches depends on the suite of wildlife species being managed for. ▪ Manage and monitor cattle use of upland woody vegetation to ensure trees and shrubs are healthy and capable of regenerating. ▪ Consider local ecological conditions, the distribution of valued habitat components, and the life histories of priority and select management species when developing grazing management plans. ▪ Pay attention to appropriate management of cattle in riparian areas. ▪ Apply a flexible and adaptive approach to grazing management. ▪ Monitor range condition (range health) and adjust stocking rates in relation to condition / health scores as well as wildlife habitat values. Consider the contribution of wild grazers when setting stocking rates. Reduce stocking rates during drought periods. Proper use factors of 40% and 50% utilization have been recommended for fescue and mixed or dry mixedgrass prairie, respectively. ▪ Promote the use of multiple grazing systems best suited to meet local conditions and management goals of local operations. Multiple grazing systems will increase the range of variability on a landscape scale. ▪ Promote rest periods to restore cover values for wildlife species. For example, leaving one field or a portion of a field undisturbed during the peak nesting period (from May to mid-July) may increase cover available to ground nesting birds. ▪ Carefully plan the development of new livestock facilities (*eg*., watering facilities, fences, corrals, handling facilities, *etc*.) in relation to critical habitat features such as leks, hibernacula, traditional nesting sites or key winter ranges. ▪ Minimize the use of supplemental feeding practices that allow for the potential spread of exotic species. Where possible, limit feeding stations to existing cultivated areas or seeded pastures and avoid placing feeding stations near to critical wildlife habitat features. ▪ Avoid creating dugouts in ephemeral or permanent wetlands to maintain their value as breeding sites for amphibians. ▪ Defer early season use of native prairie where possible, but avoid converting native prairie to seeded pasture to accommodate deferred use. ▪ Use livestock distribution tactics (*e.g.,* salt or water) to minimize impact to sensitive wildlife habitats, create heterogeneous cover, or to enhance habitat for species like the mountain plover which benefits from heavier use.

GRAZING RECOMMENDATIONS Continued

Riparian area management

- Careful management of riparian areas can help to retain their value as important habitats to numerous wildlife species. Riparian habitats associated with streams, rivers and wetlands in the Milk River Basin provide important habitat for northern leopard frogs, great plains toads, sharp-tailed grouse, loggerhead shrikes, ferruginous hawks, golden eagles, Swainson's hawks, western small-footed bats, Weidemeyer's admiral butterflies, mule deer and white-tailed deer.
- Defer use of riparian areas during vulnerable periods (*i.e.,* spring and fall) when banks are saturated and easily damaged or when woody species are vulnerable to browsing.
- Observe appropriate utilization rates (between 25% to 65%).
- Use off-stream watering and salt placement to reduce impact to riparian areas.
- Provide gravelled or hardened access points for livestock along rivers or streams at high use areas.
- Promote the use of deferred or rest-rotation grazing systems, where appropriate, to provide periods of rest and recovery.
- Consider the use of riparian pastures in areas with distinct upland and lowland areas to create more homogenous vegetation units and better control livestock distribution. Riparian pastures are created by fencing off riparian areas as separate unit from the upland.
- Consider the use of temporary exclusion fencing to improve severely degraded riparian areas or protect critical habitats such as leopard frog breeding ponds.

Grazing System Properties – Comparative Summary

<u>Season-Long (Continuous) grazing</u>

Properties:

- Livestock are held within one grazing unit (field) for the duration of the grazing season (usually the active growing season).

Potential impacts:

- Can create patchy grazing under appropriate light to moderate stocking rates and with effective use of livestock distribution techniques. Patchy grazing is the result of selective grazing where forage supply exceeds demand. Grazed patches are maintained by repeated grazing of regrowth that is preferred to more mature vegetation. Patchy grazing creates heterogeneous grassland and more diverse habitat for wildlife.
- Has the potential to heavily impact riparian areas and associated wildlife habitat. Potential for impact to riparian areas is increased under heavy stocking rates, limited water sources, ineffective use of livestock distribution techniques, and in pastures with variable terrain and distinct upland and lowland areas.

GRAZING RECOMMENDATIONS Continued

Grazing System Properties – Comparative Summary Continued

Season-Long (Continuous) grazing Cont'd.

Potential Impacts:

- Potential impacts to breeding areas depend on livestock entry dates. Generally, season-long grazing does not defer use during the early season and, therefore, does not allow for control of potential impacts to breeding areas or other critical wildlife habitats during the spring.
- Temporary fencing may be required to prevent impact to sensitive features at critical times of the year under this grazing system.
- Season-long grazing during the fall and winter is considered appropriate for fescue prairie. Winter or late season use in fescue prairie may benefit wildlife such as grassland birds by reducing litter build-up or creating favourable vegetation structure, with minimal impacts during the breeding season. Fall grazing of fescue prairie can also improve the range for mule and white-tailed deer by removing old growth and stimulating the production of new growth. This can improve the quality and availability of spring forage for deer.

Switchback / Deferred / Rest Rotation

Properties:

- Deferred early season grazing is rotated among two fields (switchback), or among three or more fields (deferred rotation grazing). Under deferred rotation grazing fields grazed first in one year (early) are grazed last (late) during the next year and grazed second (mid) in the subsequent year. Rest rotation grazing requires a minimum of four fields to be implemented, with one field rested from grazing for an entire year, and other fields grazed either early, mid or late in the year. Grazing use or rest is rotated between fields in a sequential fashion.

Potential impacts:

- Allows a field or part of a field to be rested during critical periods to wildlife such as the spring breeding season.
- Early-season deferral may improve cover values for ground nesting birds such as sharp-tailed grouse, short-eared owls, Sprague's pipits and Baird's sparrows. Spring deferral helps lessen disturbance to these birds during breeding, nesting and peak hatching. Deferred early season use can also be used to limits impacts to leopard frog, plains spadefoot toad and great plains toad breeding ponds and reptile hibernacula and birthing areas.
- Allows for deferred use in riparian areas during sensitive periods and permits periodic rest of these areas.

GRAZING RECOMMENDATIONS Continued

Grazing System Properties – Comparative Summary Continued

Complementary Grazing

Properties:

- Native prairie is fenced out as a separate grazing unit from seeded pasture. Seeded pastures are grazed in the spring (from late April to mid-June) and in the fall (mid-September to October).

Potential impacts:

- Allows for deferred early season use of native prairie, minimizing potential impacts during sensitive breeding periods.
- This system is most beneficial to wildlife if seeded pastures already exist within the grazing operation or where it is possible to convert marginal cropland to seeded pasture. Benefits to wildlife are diminished where seeded pasture is created at the expense of native prairie.
- Seeded pasture provides supplemental forage for mule and white-tailed deer in the spring and fall.

Intensive Grazing (e.g., high-intensity-low frequency grazing /short duration grazing)

Properties:

- Intensive grazing systems involve very high stocking rates and utilization followed by long periods of rest. Under intensive grazing systems there is rigid control of animal distribution with the use of numerous smaller grazing units. Continual monitoring is required to adjust grazing periods and stocking rates and to match the prevailing growing conditions.

Potential impacts:

- Heavy stocking rates with repeated high intensity trampling can reduce soil infiltration rates and increase erosion and lead to declines in range condition, lower root mass and lower vegetation densities.
- Heavy stocking rates, even for short periods can have negative impacts on critical habitat features such as breeding ponds or riparian habitats.
- Intensive systems can create uniform grazing effects and diminish nesting, escape or thermal cover for ground nesting birds (*e.g.,* sharp-tailed grouse, Sprague's pipit and Baird's sparrow), small mammal prey species (*e.g.,* meadow voles), and reptiles (*e.g.,* prairie rattlesnake and plains hognose snakes). Potential impacts to wildlife depend on the duration of intervening rest periods and the timing of grazing.
- Intensive grazing may create suitable habitat for mountain plovers and Richardson's ground squirrels and may improve foraging opportunities for raptors such as ferruginous hawks, Swainson's hawks and golden eagles.

1.5 Closing Remarks

The recommendations provided in this report provide a general framework for multi-species habitat conservation as part of the MULTISAR project. However, these recommendations are not exhaustive and are not static. Ongoing research initiatives will help to provide management direction and set management priorities. Recommendations should be reviewed, added to, and amended where necessary with feedback from appropriate agencies, landowners and other interested parties.

2 REFERENCES

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